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PATENTS AS A FACTOR IN A MANUFACTURING BUSINESS.

III. PATENT KNOWLEDGE NEEDED BEFORE ISSUING A NEW PRODUCT.

By Edwin J. Prindle, of the New York Bar.

Mr. Prindle's series began in our issue for September last, and the preceding parts have traced very clearly the influence which patents may exert in making markets and commanding success, the protection they afford their owners, and the very large part they may play in opening opportunities for perfectly legitimate manufacturing and commercial combinations. The present installment quite sustains the standards of thorough synopsis and lucid demonstration set by the earlier parts of the review.—THE EDITORS.

THERE are three forms of direct patent protection which it is possible to use to obtain a monopoly of a product, and one form of indirect protection. The first and best protection would be that of a patent on the product itself. In order to obtain a patent on the product the product must be new. If the product is one which is covered by a patent, but the patent for which is about to expire, it would not be sufficient merely to make a slight improvement, because the patent would only cover the improvement. The form of the product covered by the original patent would be public property and anyone could make or use or sell it. It is quite often supposed that by getting a new patent, not only is the improvement covered, but the elements of the product which were the subject of the first patent are also protected. I have shown in the second article in the October issue on page 96, that to omit an element of a claim without substituting any equivalent is to avoid the claim. Thus, if the improved product had five elements, A, B, C, D, and E, and the

product as covered by the original patent had only four of these elements, A, B, C, and D, the patent on the improvement would cover the use of only the elements, A, B, C, and D, without the element E; and, moreover, the second patent, if it had the effect of covering the product of the first patent, would be void because it covered what must become public property at the expiration of the first patent.

For instance, in the first planer, the return of the table was no quicker than the cutting travel. Suppose the patent on this planer were about to expire, and in an attempt to extend the monopoly, the inventor had invented the quick return. The second patent would protect the quick return, but anyone else could make the planer without the quick return, for that was the subject of the first patent, and, on the expiration of that patent, what is disclosed became public property. If, however, the quick-return planer could displace the old planer, because of its greater efficiency, the monopoly would practically be extended.

If the product could be so greatly improved as completely or largely to supplant the old form, then a patent on the improved product would practically extend the monopoly.

While it may seem impossible to improve a product so as to secure a new patent, this is frequently being done. In a paper on "The Art of Inventing," published in the July proceedings of the American Institute of Electrical Engineers, and reviewed in the September number of THE ENGINEERING MAGAZINE, I have endeavored to outline the procedure in making such a new invention.

An exceedingly interesting instance of an attempt to prolong the monopoly after the expiration of the original patent, is the case of the telephone. The main Bell-telephone patent was issued in 1876 and expired in 1893. In 1877 an application for patent was filed by Berliner, and this application was kept alive in the Patent Office until 1891, when the patent was issued. The best form, and practically the only commercial form, of telephone transmitter is the loose carbon or microphone transmitter, and the Bell Company contended that this Berliner patent covered this transmitter. In 1903, the patent was held by the court to cover only a transmitter having metallic contacts, and not to cover the microphone transmitter; but if the company's contention had been sustained, the monopoly would have extended from 1876 to 1908.

The second way in which the product can be protected is to patent a process of making that product, by which the product can be made

either of a quality which is superior to any similar product on the market, or by which it can be made cheaper than any other product of the same quality.

The method of casting car-wheels, described on page 812 of the September article of this series, is an instance. The commercial process of making calcium carbide is another instance. In this case both the only commercial process for making calcium carbide and the only commercial form of calcium carbide are the subject of patents owned by the same concern, so that there is a double protection. The Harvey process of making armor plate was, until a better process was discovered, another instance.

Every product is made by some process; that is, as stated on page 811 of the September issue of THE ENGINEERING MAGAZINE, by a series of steps or operations for accomplishing a physical or chemical result. In most cases the process is old and is therefore unpatentable, and this is what the courts mean when they say that the mere function of a machine is unpatentable; but if the series of steps or operations performed by the machine is radically different from any series of steps ever performed for the same purpose, it may be patentable.

If the process covers the only possible way of making the product, the process is as good protection as the patent on the product itself. The Bessemer process of making steel afforded a practical monopoly of the kinds of steel that were adapted to be made by that process. The process was so cheap that for the same kinds and qualities of steel, no other process could compete.

The patent on the product covers the product, whatever may be the process or machine used in manufacturing. The patent on the process covers the process, whatever may be the apparatus used in practising the process. It is of course desirable to patent both the product and the process, if possible. In the case of the phonograph, both the machine and the method by which it reproduces sound were the subject of patents, affording a double protection.

In an effort to control a certain product as long as possible, the product itself was first patented. Then, in order to provide against the contingency of the patent on the product being declared invalid, and also to extend the monopoly beyond the term of that patent, it was decided to obtain, if possible, patents covering all feasible processes of making the product. There were two steps or operations which were essential to the production of the product, and upon consideration it was seen that there were but three orders in which those steps could be performed; first, in the order A-B, and then in the reverse

order B-A, and then both steps together. Order A-B was the old order, but it did not produce an article having the desired qualities. The inventor had already invented the order B-A, but he proceeded to invent a way by which both steps could be performed together, and the patenting of the two processes consisting of the order B-A and then the two steps together would cover generically all possible ways of making the article, and by arranging to have the patents on the processes not issued until after the patent on the article had been issued, he would extend his monopoly so long as the patents on the two processes were in force, because no one could make the article without using one of the two processes. Others might invent ways that were better in detail than those invented by the inventor in question, but as whatever way was invented would be certain either to use the steps in the order B-A or to use both steps together, such new ways would be certain to embody the broad principle covered by one or the other patent and could thus be enjoined.

The third way of protecting the product would be to invent a machine which would make a product of better quality or of less cost than those already on the market. Paraffined paper was practically monopolized by the invention of the first successful machine for paraffine paper.

The fourth way to protect the product would be to tie it up with some other patent. For instance, there was the button fastener for fastening buttons upon shoes, mentioned in the October article, and on which there was no patent. These fasteners were driven by hand tools. A machine was invented for driving these fasteners by the mere movement of a treadle, the machine being so simple that it could be sold to shoe-dealers throughout the country as well as to shoe manufacturers. The button-setting machine was sold only under licenses which permitted its use only with button fasteners purchased of the manufacturers of the machine. These licenses were valid and enforceable, and the machines practically drove the hand-setting tools out of the market. Thus the patent on the machine practically gave a monopoly of the button fastener itself, and the manufacturers of the machines were as well off as if they had a patent on the button fastener.

Another example of the protection of an unpatentable product by tying it up to a patent on something else is that of the shoe-making machines referred to on page 89 of the October issue, which were unpatented but which were protected by a license on a shoe-sewing

machine, the shoe-sewing machine being almost absolutely necessary to the shoe manufacturer and the shoe manufacturer being forbidden to use the shoe-sewing machine with any other shoe-making machines for certain specified operations, unless those other machines were made by the manufacturers of the patented machines.

Of course, if the product be new or be improved, the manufacturer will have an investigation made to see whether a patent can be obtained on the product, and similarly with the process for making it and the machine for making it.

It is desirable to patent the new product, or process or machine for making it, for several reasons. The patent not only keeps down competition, but it prevents anyone else from obtaining a patent on the same thing. It is much cheaper to patent the device oneself than to defend a suit for infringement brought by someone else who has patented the invention afterwards, because, even though the patent in the latter case would be invalid, it is expensive to prove that in an infringement suit, whereas the cost of obtaining a patent oneself would be comparatively slight. If the first manufacturer patented the device, the Patent Office would reject an application for patent by the second manufacturer in view of the patent granted to the first manufacturer. I have known of an instance where a company made an investigation and put it to work in its own works, and someone else saw it in their works and patented the invention, and then sued the company which originated it. The history of inventions shows that it is generally impossible to keep them secret. It does not do to rely upon the faithfulness of employees to prevent the knowledge of the invention leaking out. If a rival wants badly enough to know how anything is done, and is willing to spend sufficient money, he can usually get what he wants.

When a commercially undesirable form of product is invented, it should be considered whether the principle of the form is absolutely bad, or whether it is possible that principle could be embodied in some different form that might be desirable. If there is any probability that the principle could be made use of by some competitor who might invent a more commercial application of that principle, then it is desirable to patent the commercially undesirable form embodying the principle, because the broad claims on the principle would be as valid in a patent showing the undesirable form as in a patent showing a more desirable form.

But whether or not it is found that the product or process or machine is patentable, it is also necessary to make a further investi-

gation of the patents already granted to see whether there is any existing patent with a valid claim that can be used to stop the manufacture, use, or sale of the product or process or machine. This is a point that seems to give a good deal of difficulty, not only to the manufacturer, but to many lawyers who do not make a specialty of patents, and even to the courts. It is reasoned that if the Patent Office recognizes the new product or process or machine as being so different from all previous devices or processes of the same kind as to grant a patent upon it, then it cannot be an infringement of anyone's else patent. The Supreme Court of the United States, however, has expressly decided that even though the new device or process may be better than all others and may be patentable, it may still be an infringement of a previous patent. When Bell obtained his patents on the telephone, a host of inventors immediately went to work to improve the telephone, and Edison, Blake, and Berliner and others produced telephones that were better than Bell's telephones; and yet they could not use their improved telephones during the seventeen years that the Bell patents were in force, without the consent of Bell or his assignees, because their telephones, although better than Bell's, embodied the principles of Bell's invention, and Bell was entitled to an absolute monopoly of those principles, whether used in a better telephone than his or not. The matter may perhaps be made clearer by a number of comparisons. Suppose the first inventor of cast iron had obtained a patent upon the combination of iron and carbon; he would not only be able to prevent the use of this combination for making cast iron, but also for making steel in all its varieties and every form of product in which iron and carbon were combined together.

Suppose that the prior patent is infringed and no way is seen to avoid infringement by changing the product or the process or the machine so as not to embody the principle of a patented invention. The simplest way, of course, would be to buy the patent. If the patent cannot be bought, but a fraction of the patent can be obtained, no matter how small a fraction, say one-tenth of the entire right in the patent, the owner of the one-tenth would be just as well off as the owner of the nine-tenths. The courts have held that a patent is not like the capital stock of a corporation, and that the owner of more than one-half of the title to the patent has no claim upon the owner of less than one-half. Each one is at liberty to do with his portion what he pleases, and cannot, in the absence of an agreement to that effect, be made to account to the other.

The owner of one-tenth may make ten times as much out of the patent as the owner of nine-tenths, because of his greater business ability or greater capital, or for other similar reasons, and it would not be equitable to make him turn over nine-tenths of his profits to the other owner.

Competitors have been enjoined from making a product where the competitor sold a patent which he knew to be invalid, the competitor intending to get the purchase money for the patent and also to continue manufacturing the product because he knew the patent was invalid; but the courts will not permit a man to sell a patent and then to say that what he sold was worthless, so that although the patent may be invalid as against all the rest of the world, it is valid as against the man who sold it, and the man who purchased the patent would be able to keep the seller out of the market for the balance of the life of the patent.

It is not sufficient that the new product be illustrated and described in a prior patent; if it is not covered by the claim of the patent, then the patent cannot be used to enjoin the product. Often the drawing of a patent will illustrate a big machine, but the claims will be found to cover only a small portion or detail of the machine, and it is only this portion that is described by the claim that is protected by the patent.

If a prior patent is found that has a claim covering the new product, but if it can be shown that before the invention of the prior patentee any of the defenses existed which are enumerated on page 813 of the September issue of THE ENGINEERING MAGAZINE, then the patent can be disregarded, as no suit under the patent could be successful. There are numerous other defenses which could not be well enumerated in a series like the present series of articles. If the prior patent has a claim which covers the new product or process or machine, and it can be shown that before the patentee's invention there existed in a manner accessible to the public a structure or process sufficiently like the product or process or machine which it is desired to put out, so that if the claim be given a broad enough scope to include the new process or product or machine, it will also include the old structure or process, then the court may say that the claim is valid for the detail or difference which the patentee has over the old structure or process, but that it would be invalid if construed broadly enough to include the new product or process. In this way the claim may be limited by the prior art sufficiently to let the new process or product out from the charge of in-

fringement, and yet the claim may be sustained as valid. The reasoning would be that if the patentee had not claimed the detail his patent would be invalid. Therefore the patent would not be infringed, unless that detail were used.

The law does not require that a new product, process, or machine be patented before it is put on the market, but it allows two years of public use or sale of the invention in order that the inventor may thoroughly test his article and be sure that it is satisfactory, and in order that he may earn some profits from his invention. The law distinguishes between use or sale to test an invention, and public use or sale after it is evident the invention is complete. Use to test the invention to see whether it is perfect and complete, which the law calls "experimental use," does not count. It is only two years public use or sale after the invention is complete that will destroy the right to a patent. The case of the Nicholson wooden pavement, which was first laid in Elizabeth, New Jersey, illustrates this. Nicholson laid his pavement in the public street, and the court held that a certain amount of use of this pavement in this public way was only experimental use in order that he might determine whether the pavement was satisfactory, and that the two years did not begin to run until the experimental period was over.

To summarize: in putting out a new product, the product should be protected by a patent on the product itself if possible. If not, then it should be protected, if possible, either by inventing and patenting a new process by which the product can be made better or cheaper than before, or by inventing and patenting a machine for that purpose. If none of these ways is feasible, it should be be considered whether or not the product cannot be tied up in some way with a patent on some other product, process, or machine. In seeking to produce any of these inventions through employees, the precautions should be observed which will be stated in the December article of this series.

A MODERN ADAPTATION OF THE APPRENTICE-SHIP SYSTEM.

By O. M. Becker.

The question to which Mr. Becker addresses himself is one which has been asked by many thoughtful industrial managers—where are the mechanics of the near future to come from? The tendency of the practice of to-day is to consume and blight the very material from which it was created. It is not denied that conditions have changed, permanently, and that a very large proportion of the mechanical work of the world will hereafter be done by operatives who do not need and could not use the training of the old-time mechanic; but the very system which creates the conditions calling forth this class of labor, creates also a growing need for more of the "all-round" machinists without providing the natural opportunities for their training.

The problem is being attacked in many ways, by many employers, and Mr. Becker assembles their experiences and from them constructs a working system adaptable to the circumstances of the average shop. The second and concluding part of his discussion, which will appear next month, follow up the question of the instruction of apprentices and will be largely illustrated with photographs taken in representative works and the forms of agreement, indenture, etc., which been have found satisfactory in use.—THE EDITORS.

THE mitigation of the incapacitating effect produced by the monotonous repetitive processes which are apparently a necessary concomitant of piece-work, and therefore of the modern factory system, is more and more regarded as an important industrial problem. This problem has a two-fold aspect. The one affects the life and social character of the worker, and is therefore of vital interest to society; the other, that here considered, concerns the efficiency of the worker, and therefore the permanency of the industrial system as now constituted.

The development of the jig, the rig, and the special machine have resulted in the practical elimination of the skilled workman from the manufacturing shop. He is succeeded by the piece worker, who has learned to do just one infinitesimal part in the productive process, and does that mechanically. Curiously enough there has been developing, along with this decreasing opportunity for the training of skilled workers in the manufacturing shop, an increased requirement for skilled workmen also. That is to say, while manufacturing machines and tools have been becoming more and more specialized and more and more nearly automatic, the building of these machines themselves, and the directing of the men who manipulate them, has

been calling for more men of a high order of mechanical skill and all-round ability. And the supply of first-class men of this sort, as nearly every employer knows, for a number of years has been unequal to the demand. Furthermore, a very large proportion of the supply have been foreigners, who obtained their training in their native countries. The American-born skilled workman is coming to be all but unknown, and the reputation of the American workman for turning out superior products is in reality a reputation belonging in large part to the foreign-born mechanic working in American shops under American methods.

The American boy is thoroughly imbued with the "get rich quick" spirit, whether in a greater or lesser degree. The learning of a trade is too slow, too tedious, and offers too little immediate inducement. Why should he work as an apprentice at four to eight cents an hour, after reaching the age of seventeen or eighteen, when he can earn ten to fifteen cents at piece-work, running a machine? Once he has entered the door of the piece-work shop, the boy is doomed to the piece-worker's life. Once the machine gets its grip upon him he never escapes. The rare exception only proves the rule. Not only does the monotony of the reduplicative work upon which he enters choke his ambition and devitalize his life, but usually he enters upon this narrow life work with very little equipment and a view bounded by a horizon equally narrow. There is little to develop, even when there is some ambition to begin with.

Workers of this sort will turn out work of the required quality, and in satisfactory quantity usually, because it is difficult in this age of jigs and automatic machines not to do so. With the possibility of increasing the efficiency of these producers we are not at this moment concerned, though this is, as already pointed out, in itself a serious problem. These machine workers need supervision, intelligent direction; and the question is where to get the foremen and assistants capable of giving it. They are not to be found, still speaking in general terms, among the workmen themselves; for the nature of the work one man is permitted to do is so little varied that even an ambitious man of unusual intelligence would have little opportunity of acquiring sufficient knowledge and skill to handle the shop efficiently. Furthermore, the stultifying influence of piece-work disinclines men to assuming responsibility; so that, even if a competent man be found for a foremanship, the chances are that he would be unwilling to give up his accustomed job in order to shoulder responsibilities to which he has never been used. The testimony of man-

agers and superintendents is pretty conclusive on this point. The alternative is to take the foreman from among those all-round skilled men who show ability to handle men and organize production, or to get them in the open market. But as already pointed out, the supply of these in any shop is not nearly equal to the demand; and as for the alternative, every employer is already in the "open market" getting such men as best he can in competition with all the others, and incidentally losing some of his own.

Whence, then, shall come the supply of skilled workmen to meet the requirements of this constantly expanding industrialism?

Three sources suggest themselves: trade schools, factory schools, and a revival of the apprenticeship system. Trade and industrial schools of the various sorts are not rising to the occasion. To begin with, their number in the United States, at least, is insignificant. Of the other classes of industrial schools, including manual-training schools, the number is far from being as great as it ought to be. Such industrial schools serve a useful purpose, but their effect upon the problem of supplying the manufacturing industries with a sufficiency of competent and skilled workmen is scarcely appreciable. Of the few trade schools we have, less than half a dozen, so far as an extended investigation reveals, undertake to meet the situation squarely by making the learning of a trade under the conditions that prevail in the actual productive shop the primary object, and the acquisition of "book learning" and mere dexterity of secondary importance. Book learning and "training" are excellent, and sufficient unto themselves, as far as they go. But these things are not what the average American boy wants most or needs most. He wants to get out into the world of money-earning at the earliest moment he can. The future good in an extended school course does not appeal strongly to him, because he wants to get dollars immediately. This being the case, as conditions now are, he goes straight to the factory and becomes a piece worker. Here is the opportunity of the properly organized school of trades (as Prof. John E. Sweet insists upon calling them, in distinction from the trade schools as usually organized) to perform a tremendous service not only to the industrial world, but to society. But unfortunately we have practically no such schools, wherein the young industrialist can in a comparatively short time get the skill and experience that will fit him for the machine shop or other skilled trade, or perhaps to become, after some years of experience as a journeyman, a foreman of a piecework shop. The artisan school recently opened in Syracuse, N. Y.,

under Professor Sweet's directorship, is the one notable exception to this statement, and the single American example known to me.

Germany has a plenty of schools for artisans, most of them of the supplementary sort, giving the man or boy already at work an opportunity to learn a trade. The result is well-known. France and other Continental countries have also excellent systems of schools planned upon the same general lines. Our boast as Americans is that we can have anything that anybody else has. Doubtless we can. But we don't. We have some of the best technical schools for the training of engineers that exist. But they do not train, in any adequate way, for the humble trades nor for those intermediate positions in productive and distributive plants that the professional engineer esteems beneath his dignity, but the proper filling of which is vital to the prosperity of any business. The fact that practically every trade school in the United States is full to overflowing, and that whenever a new school is announced the applications for registration uniformly exceed the intended capacity, is clear evidence that young America has not yet become possessed of money-madness to the extent that he will not take advantage of what seems a rational opportunity to prepare for a useful life work.

Since, for the present, at any rate, little relief can be expected from the trade schools, it remains to consider what may come out of a revival of the apprenticeship system and the establishment of factory schools.

Of American factory schools there are but a very few worthy of serious consideration. The apprenticeship schools of R. Hoe & Co., of New York, and the General Electric Works, at East Lynn, together with the Casino Technical Night School, conducted in connection with the Westinghouse plants, are the notable schools of this sort. All these, however, are merely adjuncts to the apprenticeship systems maintained by these companies. So far as is now apparent, therefore, there is little likelihood that such schools may in the immediate future become recognized agencies for training factory employees, except as in the cases mentioned, in connection with apprenticeship systems. It would seem therefore that a general inauguration of such systems is the most likely to afford immediate relief to the situation.

Obviously the old-time system of apprentices indentured to a master for a seven-year period or longer, is unsuited to present-day conditions and methods. Under the former conditions of apprenticeship it was to the interest of the master to teach the learner as much

of the trade as possible in the early portion of the period of indenture, in order to reduce to the minimum the profitless portion and to secure the largest amount of skilled work from the apprentice before he became entitled to the increased journeyman's wages. Not only is a seven-years indenture out of the question because nobody would enter into it, or fulfill its terms if he did make the agreement; but the conditions prevailing in the modern shop do not tend to encourage the apprentice to learn the whole trade, or to give him the opportunity to do it if he is so inclined. Every machine shop and other shop the workmen in which are skilled mechanics, whatever their trade, nowadays partakes largely of the nature of the ordinary manufacturing shop. The object is to specialize as largely as possible and to approximate as closely as may be the piece-work system. In fact, this system, somewhat modified, is already in actual use in some machine shops and bids fair to be extended to many others before very long.

Under the old system the waste of time to the apprentice was undoubtedly very great. Present practice does not insist upon such long indentures, and there is therefore a saving in time. But the tendency to specialize, in shops of whatsoever sort, makes it difficult for the apprentice to learn more than a small part of the trade well, even where he has proper instruction, because it is more immediately profitable to keep him at the particular machine or job he has already learned, turning out a maximum of work limited in variety, than to teach him, or allow him to learn, a variety of operations and machines. As the work of the machine shop becomes more and more specialized there will doubtless be an increasing field of usefulness for men skilled in the use of a limited number of machines and capable of doing a relatively small number of different kinds of jobs. For such the time of apprenticeship might be reduced considerably, and in fact this is already done in practice in many places. However that may be, the larger need, for some time to come, will be for all-round men in the trades, men capable of doing any job in the shop. The proper training of such men is a matter deserving serious consideration.

It is true that many shops throughout the United States take in apprentices and a few others have a well outlined scheme of instruction for those they take in; but it would be incorrect to say that there is any such thing as an apprenticeship system in vogue in the United States. In most shops there is nothing more than this: a few boys are employed with a more or less distinct verbal agreement that they

shall remain in the shop a specified time. They are under the foremen just as are the journeymen, and are supposed to receive some instruction from both. As a matter of fact they leave when they please, and receive little or no instruction except where the foremen or some journeyman takes a particular interest and goes out of his way to teach the "cubs" the things they would otherwise have to pick up as best they might—if indeed they pick them up at all. The inefficiency of such a lack of system scarcely needs to be pointed out.

In a few plants an effort has been made to systematize the mode of employing, instructing, and promoting apprentices. The classic examples in America are Brown & Sharpe Manufacturing Co., R. Hoe & Co., and Baldwin Locomotive Works. There are others, of course—a good many, in fact, whose experiences are less widely known. Among these are the Westinghouse Companies, General Electric Co., (at the West Lynn works), and the Allis-Chalmers Co. Practically all who have had experience in the matter, even with very indifferently organized systems, declare that the results are good as far as they go. But it is recognized on all hands that they do not go far enough. The difficulty of keeping boys long enough to learn a trade, and the wastefulness of haphazard instruction or no instruction at all to speak of, together indicate the necessity for a rational organization based on modern needs and conditions.

The National Metal Trades Association has officially recognized the necessity for a proper apprenticeship system as a means for the education and training of skilled mechanics, and has formulated a set of conditions which its members are advised to incorporate in their apprenticeship agreements or regulations, substantially as follows:

1. No boy will be engaged as apprentice who is under fifteen years of age.
2. The regular time of apprenticeship shall consist of four years.
3. The period is to be divided so that the apprentice may obtain experience in the various classes of work and upon different tools.
4. A boy successfully completing his four years of apprenticeship shall receive a certificate to that effect, signed by the proper officers of the company or members of the firm.
5. The member should agree to give the boy every opportunity to become a thorough mechanic, by advancing him to better grades of work from time to time, as he demonstrates his ability and willingness for advancement.
6. We recommend that as generous compensation be given boys as circumstances will permit. (Table of rates in vogue in different cities at the time of formulating the rules is here omitted.)
7. In consideration of continual, faithful and satisfactory performance of the contract, and furthermore as an incentive to diligence, a bonus of at least $100.00 should be paid the apprentice at the completion of his contract.

8. The member shall reserve the right to dismiss a boy who does not prove diligent, trustworthy, or competent, and a boy so dismissed, or leaving before the expiration of his time, shall not be entitled to any bonus.

9. In all cases the consent of the parent or guardian shall be obtained.

10. It is recommended that for further experience, the apprentice be advised to leave the service of the firm with whom he has served his apprenticeship, for one year; shall receive from his employer a recommendation to other firms of the National Metal Trades Association, and such apprentice should receive preference from N. M. T. A. members.

11. Apprentices who leave their employment for good and sufficient reason should receive a certificate covering the period served.

12. We recommend that members of this association shall decline to employ any apprentice who may have left his employer, with whom he has a contract, without the employer's consent, before the entire completion of the contract.

Most of these provisions might well be incorporated in any system of apprenticeship, whether the employer were a member of the association named or not. There is however one omission that vitally affects the successful working of such a system, namely, the instruction and supervision of the apprentices. Without intelligent direction, and competent and regular instruction, both in the mechanical operations and in the academic and technical elements essential to the well equipped mechanic, the apprentice gains little, and the employer probably less, from the adoption of such a system. This supervision and instruction is the prime essential in an apprenticeship system, as all experience and reason plainly show. The fundamental reason for a system is efficiency; that is, the acquisition of a maximum of skill and experience in a minimum of time. Left to his own devices, how can efficiency be expected in the apprentice? And why should he be particularly interested, with so little incentive or opportunity for acquiring a working knowledge of the trade or business?

How such instruction and direction should be organized is as yet an open question. There can be little doubt, in the light of the experiences of the few employers who have kept their faith in apprentices and apprenticeships during all the years linking the old to the present *régime*, that is the part of prudence to put all the apprentices of a plant or shop in charge of one man properly equipped for such a work. It is immaterial whether he give all or only a part of his time to this work. In a large plant doubtless it would be found desirable, if not necessary, to devote practically all his time to the boys. In the small shop the time required would be proportionate to the number of apprentices employed.

It is perhaps natural that foremen should demur to such an arrangement if they have not had experience with it, thinking that it will curtail their own prerogatives and diminish their authority in

the shop. The experience of such works as the Brown & Sharpe Manufacturing Co., and the Baldwin Locomotive Works, to say nothing of many others, shows conclusively that such fears are quite groundless. The evidence is conclusive that there is no need whatever for friction, and that on the other hand no apprenticeship system can reach the maximum of efficiency without the concentration of responsibility for the progress and instruction of the apprentices in the hands of one competent man.

The qualifications of the man selected for superintending apprentices will be the determining element in the results attained. It rarely happens that the shop foreman is well suited to such supervision. Usually he could, if he would, direct the instruction in the mechanical exercises, provided it did not take too much time from his other and more important duties, as they are usually considered. Obviously an apprentice in a shop should be responsible to the foreman for his work and conduct, the same as any other workman. But if he is to make the greatest possible progress he ought to be under the eye of some one who can *and will* give the time to teach him, and who is capable of determining rational courses of work looking toward the accomplishment of the purpose of the apprenticeship, without materially impairing the commercial productiveness of the apprentice. He ought indeed to be a man of rare ability. He should be, on the personal side, of exceptionally strong character, amiable disposition, and large experience in managing men and boys, particularly the latter. The greater his acquaintance with human nature, and more especially boy nature, the better able he will be to inspire the boys and to interest them in the things worth while, both in and out of the shop. It goes without saying that he should be skilled in as many as may be of the lines of work his apprentices are learning, that he may give proper instruction as occasion may require. But it is far from sufficient that he be merely a good mechanic.

The superintendent of apprentices ought by all means to be a superior person, just as any teacher should be, for the efficiency and successful working of his system will be in proportion as he possesses sound judgment and the qualities already pointed out. There will be constant opportunity for exercising his knowledge of boy nature in the selection, promotion, transfer, and instruction of the apprentices, and in keeping in touch with them outside the shop as well as within it, watching their health and habits, and being at all times their next and best friend to whom the boys can at any time go for counsel and assistance.

ORGANIZATION AND ECONOMY IN THE RAILWAY MACHINE SHOP.

By H. W. Jacobs.

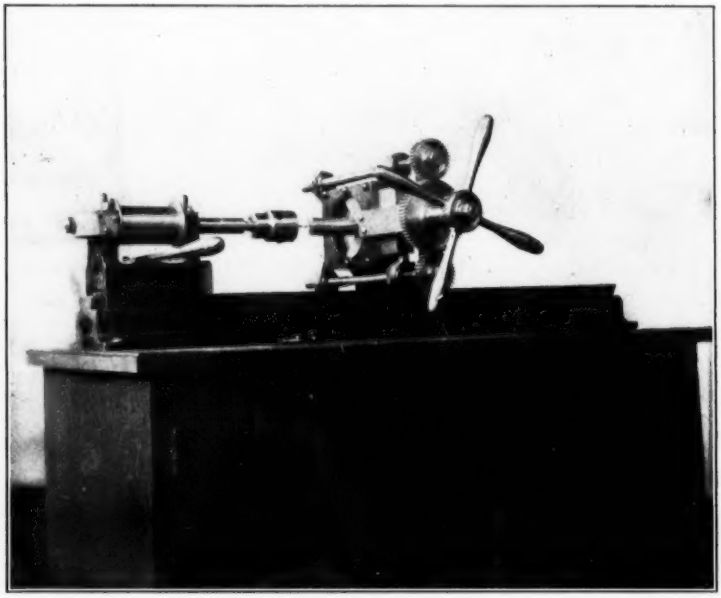
III. CENTRALIZATION AND BALANCE OF MACHINE-TOOL EQUIPMENT ON AN ENTIRE RAILROAD.

Mr. Jacobs' series began in our issue for September last, and the preceding sections have dealt thoroughly with the policy and results of standardizing equipment, operations, and tools. His next installment will cover the design, manufacture and introduction of standardized small-tool equipment, and his concluding paper will be upon erecting-shop economies. THE EDITORS.

A RAILROAD of the size with which we are dealing in these articles will have a number of lesser shops besides one or more large main shops. These lesser shops will be under different master mechanics, and each one will be provided with a machine-tool equipment, usually collected and added to during a long period of years. Many of these machines will be old, some will be new, and it will come about that fine and expensive machines, rarely used, will by chance rather than by intelligent foresight be found in small shops.

Each master mechanic, in order to lessen the burden of "grief" upon him in the way of power tied up for repairs, naturally desires to fortify himself as far as possible with a large and safe number of men, and a full and complete shop-tool equipment. As master mechanic succeeds master mechanic, different items will receive attention, and the shop will be strengthened now here, now there. One man will devote his attention to the round-house and clamor for efficient drop pits, overhead cranes, lighting and heating systems. His successor will yearly add many thousands of dollars to the machine-tool budget—large radial drill suitable for use with mud rings, a quartering machine, some patent planer or grinding machine, electric drives, or what not. Still a third will insist on all manner of small tools, abrasive wheels, air motors, valve-setting machines, jigs and devices without number; usually he has these made right in the shop and the expense does not appear on the budget nor in the requisitions, but totals up in the pay roll.

The result of this general attitude and policy on the part of the master mechanic of a division, wherein he is ably seconded and sup-



AN EFFICIENT CENTERING MACHINE DEVISED BY A TOOL-ROOM FOREMAN AND BUILT IN THE SHOPS.

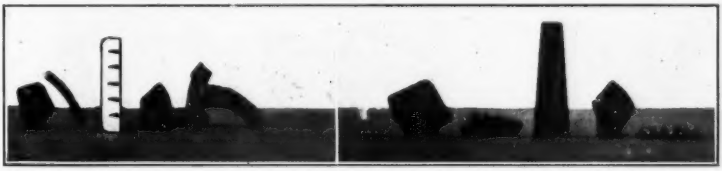
Cost less, is quicker in action, and more accurate in centering than any machine that could be found on the open market.

plemented by all the foremen under him, is that the lesser shops are usually over-equipped and over-manned for the amount of work they are supposed to turn out. The higher officials, in charge of the purse strings and the budget, exercise quite a restraining influence and keep this over-equipment from reaching extravagant proportions. A master mechanic has too much dependent upon him, in the way of keeping engines in running condition and supervision of round-houses over his division, to give close study to the question of whether the installation of certain machinery is economical, and he is often influenced by the urgency of his foremen in such matters; at the same time the higher officials must in large measure rely upon the master mechanic's recommendations, as he is the man employed to look after such interests, and they usually have no other means of determining the requirements.

When, therefore, it has been decided by the management of a railroad to organize thoroughly and to systematize clear-sightedly their mechanical department, one of the earliest moves, after the

general policy of centralization of manufacture and standardization of parts has been worked up, is to take stock of the entire shop and tool equipment of the road, and to decide upon certain broad policies in regard to the economical utilization of this equipment. Under the general plan of centralized manufacture herein outlined, it is very probable that the main shops will have to be enlarged and that their tool equipment will have to be increased. Instead, however, of purchasing large amounts of new machine tools, it will be found of great advantage to transfer to the main shops needed tools spared from the outlying shops. Of course this policy will be bitterly opposed, but it needs no argument to show that a $10,000 wheel lathe is better off in a place where it can turn out seven to ten pairs of drivers a day, than where the total shop output would permit of turning but one or two pairs; and it also needs no argument to show that it would be folly to purchase an additional new machine for the large shops when one of which so little use was being made, was available. I cite this case because it happens to be an actual one. The same rule should govern in the case of engine lathes, boring mills, slotters, and especially, large milling machines and special grinding machines.

One of the great factors of shop production improvement is the modern high-speed alloy tool steel, by the use of which many machining operations can be greatly reduced in time.



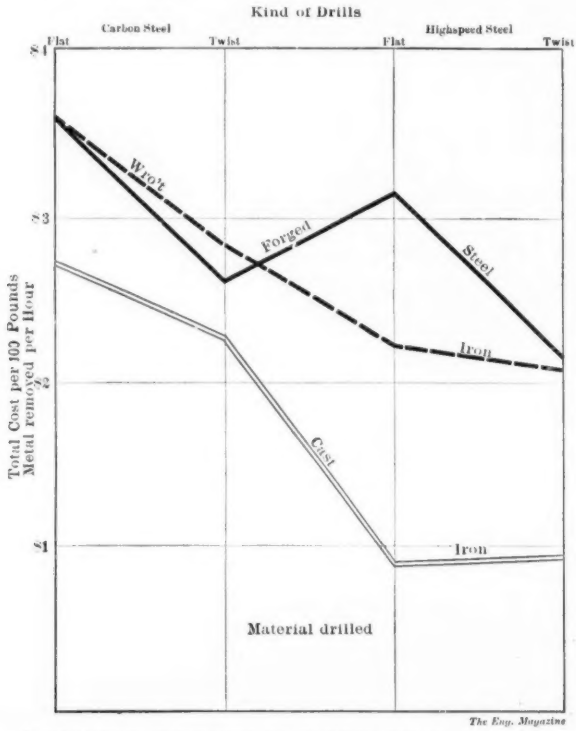
RESULTS OF TEST OF CARBON VS. ALLOY STEEL TOOLS

Showing comparative metal reduction and condition of tools. Carbon steel on the left.

This first view is of the noses of two large planer tools, the one on the left of carbon tool steel, and the one on the right of high-speed alloy steel. Beside each tool is the chip that it removed from a main rod in five seconds. The cutting edge of the carbon tool was burnt as shown after three minutes' service; the other tool kept the edge here photographed for an hour and a half, removing 780 pounds metal per hour, and was still not in need of grinding.

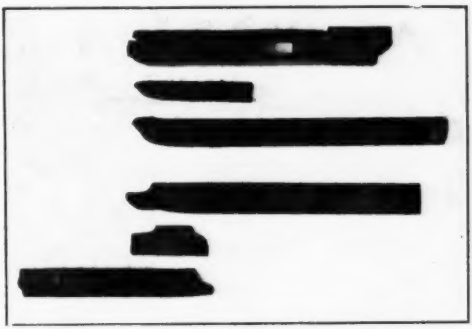
When the high-speed alloy steel was first put on the market its fiery-furnace ordeal was to stand up under the severest conditions that turning tires on the wheel lathe would subject it to. While experimenting with these steels on the wheel lathe on Krupp tires, it was found that the usual wheel-lathe tools were inefficient in de-

sign and needlessly heavy in the amount of tool steel used. To economize in the tool steel, and to standardize the flanging tools, a cast-steel holder, using only 1-inch square high-speed steel for the roughing instead of 2 inches by 3 inches, and a flat flanging cutter 5/8 inch by 2 inch, instead of a 1½-inch square bar was designed.



COMPARATIVE EFFICIENCY OF VARIOUS DRILLS, FROM TESTS.

The old flanging cutters were forged and shaped and then ground by the machinist according to his ideas as to what the shape of the flange should be. The new flat cutters, weight not one-tenth as much, were milled out to standard M.C.B. shape in the tool room, in quantity, and then hardened. They retained their edges under test about twenty times as long as the old tools, and when in need of new grinding were reground in the tool room to standard. The illustration shows the flat cutter flanked on each side by the two large flange cutters necessary under the old conditions, and shows



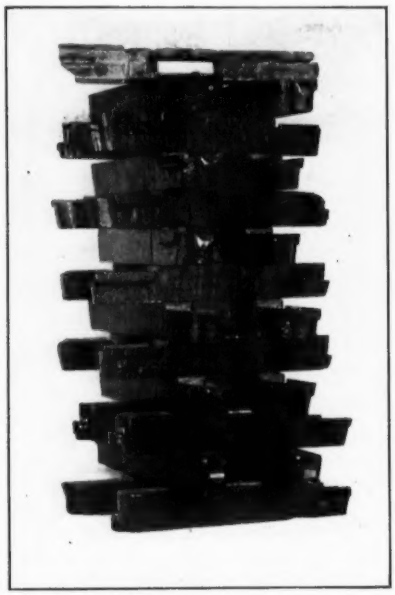
STANDARD HIGH-SPEED WHEEL-LATHE TOOLS.

also the old roughing tool, the new small roughing tool, and the cast-steel tool holder. The high-speed steel used in these two tools weighs only 3 pounds, as compared with 27 pounds for the old set. The saving of 24 pounds at 50 cents per pound, where these sets of tools are kept in duplicate or triplicate, for each shop having a wheel lathe on a railroad system, will amount to a considerable sum of money—secured by the use of a cast-steel tool holder, costing less than $1.00.

"PHANTOM" VIEW OF WHEEL-LATHE TOOL HOLDER, SHOWING CUTTING TOOLS IN PLACE.

The tool accounts on our larger railroads run from $100,000 to over $1,000,000 per year; when unnecessary expenditure for new machine-tool equipment is cut out, when needless manufacturing of small and special tools is stopped, and the tool-room force at the small shops so reduced that it is not possible to spend time and wages on such manufacturing in addition to keeping up the ordinary repairs and care of tools, and the pay roll of the tool account is checked up for each point each day, and summarized each month —it will be astonishing what reduction in this tool expense can be accomplished, without any detriment to the service, but on the other hand, with increased efficiency resulting from intelligent supervision and supply of what is needed most in order to get the work out. It

COMPARATIVE VIEW OF WHEEL-LATHE TOOL OUTFIT REQUISITE UNDER OLD AND NEW CONDITIONS.



STACK OF TOOL HOLDERS FOR SHIPMENT TO BRANCH SHOPS.

may be confidently stated that if this tool proposition is handled thoroughly, radically, and uncompromisely, the account may assuredly be cut in two.

We deal here in economies in tool equipment; by means of tools alone can we maintain our power. The tool account will not be 5 per cent of the whole cost of maintaining and renewing locomotives, yet where a 50 per-cent tool-account economy can be made, a 20 per-cent engine-repair economy is also possible, with better engines, turned out more quickly. It is with these larger and more telling economies that we have chiefly to deal.

Considerations Governing the Selection and Design of Machine-Tool Equipment.

Whenever a large shop is built, or even a small shop extended, everyone from the machinist to the highest officials on the road considers it desirable and advantageous to purchase and put into use the best modern machine tools that can be had. In fact, there is a constant tendency toward the acquisition of these new machines. We have already shown how ill-chosen in respect to the needs of a shop these purchases often are; here stress is to be laid on the fact that most of this new machinery is neither necessary nor desirable.

With the prosperous conditions existing all over the United States in the past five years, extravagance and wholesale expenditures have seemingly become rampant, not only in government and municipal undertakings, but also, concurrently with the rapid rise of consolidated industries, in the new and improved equipment necessary to carry these on in an economically centralized way. In general this policy of expansion in manufacture and centralization, and of acquiring equipment enabling such concentration, is according to economic laws; but in detail, much of this hue and cry about

new machines and modern methods, is a fad. For instance, we have many advocates of individual electric drives for machine tools. Electric cranes, electric telfers, and other electrical devices are considered very desirable and great savings in labor are claimed on their account. Similarly, big, heavy, new machines are thought essential. For several reasons much that is being done in this direction is not economical—quite the contrary—and better results would be secured if closer attention were given toward the adaptation and rebuilding of old machines with reference to the particular work in view. First, the new machines are built with such regard for massive strength that their cost is much higher owing to the weight of the material alone, and they are too heavy and cumbersome to yield rapid production. Second, notwithstanding that these machines are built with great strength and, apparently, for very heavy service, they are still supplied with cast-iron gears, for the most part incapable of transmitting large loads for any length of time. Third, many of them are supplied with electric motors on the theory that a greater and more gradual variation in speed and power and application will be effected, irrespective of cost or actual advantage in this method of drive. Fourth, the economical aspect of the machine-tool proposition does not seem to have been considered in a sufficiently comprehensive way, and the "sur-charge" or overcharge on the machine is largely neglected in estimating its time and output capabilities.

Under "surcharge" are included the following items:—

Interest on the first cost of the machine.

Depreciation of the machine.

Annual repairs on the machine, including repairs to the electric motor.

Cost of horse power delivered at the spindle.

The machine's percentages chargeable to the individual machine or

Cost, interest, insurance, depreciation, et cetera—annual rent—of the building and its appliances in which the machine is situated.

Similar percentages on the power-house equipment.

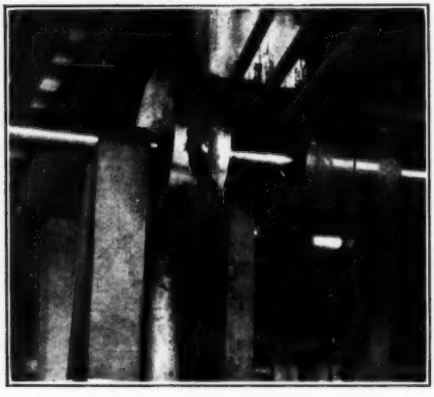
Percentages also of the supervision, clerical, and other office costs in connection with the machine.

All these items, as a rule, bear some direct ratio to the size and first cost of the machine tool, and as a consequence the overcharges are very high on some of our fine, modern heavy equipment—so

high, in fact, that it is more economical to turn a pair of drivers in three or four hours on an old wheel lathe, even where the machine is used most of the time, than to reduce the time to an hour or two hours by the use of a magnificent $10,000 machine.

These overcharges are no imaginary items, appearing only on paper, but considered in an ultimate way they are actual costs, for the "general expense" of which they represent a sub-division is a large item in any enterprise.

In many cases, therefore, better results and greater economies can be secured by close attention to and rebuilding of old machines. In general it may be said that steel gears should be substituted for cast iron, wide cone pulleys used (with perhaps fewer steps), and many devices and appliances should be furnished in order to expedite and add to the convenience of the work. Along with this redesign of the machine, of which we shall consider a few detail examples shortly, comprehensive attention should be given to the condition of the line shafting, pulleys, and belting. Good forms of standard shaft hangers and bearings should be adopted; good forms of pulleys and standard belting specified. The oiling arrangements for the shafting should be made convenient and some regular system of attending to them adopted.

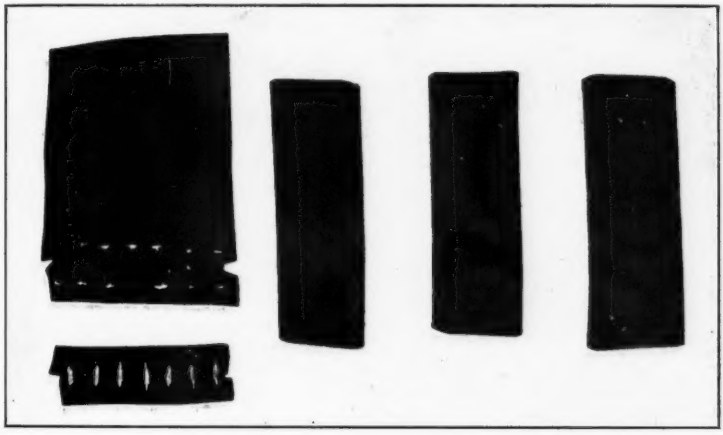


A WRONG METHOD OF PREVENTING BELT SLIPPING.

All belts should be tight, and no rosin used.

The condition of the belting determines very largely the efficiency of the machine, making very considerable difference in the producing capacity of a whole shop. Therefore this small item deserves all the attention required to maintain it in very high efficiency. It is the more desirable to do so as efficient belting inspection and repair costs less than one-third as much as the ordinary practice.

The three pictures on the right on page 185 show the various short connecting lengths kept by a belt inspector, to take up slack. The long piece is put in first, and as the belt stretches, the other pieces are substituted in



THE COMMON METHOD OF BELT FASTENING, AND AN IDEAL ONE.
The former, brass cleats; the latter, spiral-wire lacing, hinging on a raw-hide pin.

turn. The picture on the left shows a contrast to this good belt fastening.

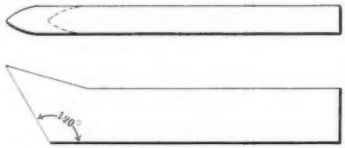
In one of the largest locomotive works in the world I saw this fastening used less than a year ago, so that it is evidently common, very common, practice. It is, however, very inefficient because the joint is much weaker than the rest of the belt, and because the mode of fastening tears the belt.

Roughly, the cost of belting, maintenance, etc., is between 1 per cent and 2 per cent of the pay-roll cost of running the machine shop; I have seen not less than three instances on a large scale of this cost being reduced to one quarter of one per cent; however, I would emphasize the matter of attention to belting not so much from the saving in the cost of the belting itself as on account of giving a better service to the general machine equipment.

After these general improvements of shafting, pulleys, belting, and strengthening of machines have been started, the next step is to speed up the line and countershafts by using larger driving pulleys. As a result of such a general move the machines will all run more rapidly from this cause alone, and an increase in production will result, of which generally, the men are unconscious, especially when the changes are made Sundays and nights. Were they conscious of any organized effort toward increasing the output they would probably spend much time and thought in an attempt to circumvent such a plan.

While these changes may be said to be going on overhead, con-

Lathe Tool

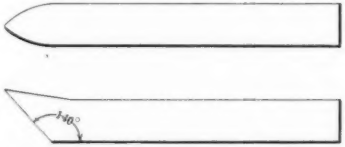


Symbol	Size inches	Symbol	Size inches
L- 8	½ x 1 x 8	L-12a	¾ x 1¾ x 9½
L-10a	5/8 x 1½ x 8½	L-14	¾ x 1½ x 10
L-10b	⅝ x 1½ x 8½	L-16	1 x 2 x 10
L-12a	¾ x 1½ x 9	L-20	1¼ x 2 x 14

Material: Highspeed Steel

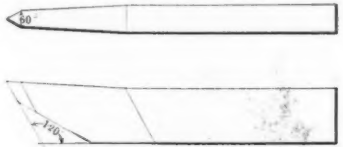
Boring & Turning Tool

Used with Patent Holder



Symbol	Size inches	Symbol	Size inches
B- 4	¼ square x 2½	B-12	¾ square x 9½
B- 5	5/16 " x 2½	B-14	⅞ " x 4½
B- 6	⅜ " x 3	B-16	1 " x 8
B- 7	7/16 " x 9	B-20	1¼ " x 8½
B- 8	½ " x 3	Material:	
B- 9	9/16 " x 9½	Highspeed Steel	
B-10	⅝ " x 3½		

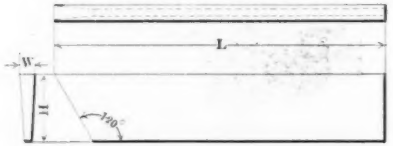
Straight Threading Tool



Symbol	Size inches	Material:
T- 8	½ x 1 x 8	Highspeed Steel
T-10	⅝ x 1¼ x 8½	
T-12	¾ x 1½ x 9	

Cutting Off Tool.

Used with Patent Holder



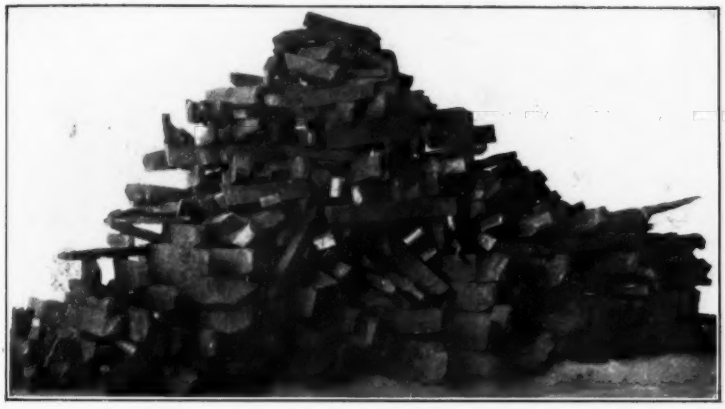
Symbol	Size inches W	H	L	Symbol	Size inches W	H	L
C-10	3/32	5/8	5½	C-16	5/32	1	8½
C-12	1/8	3/4	6½	C-18	3/16	1⅛	9½
C-14	1/8	7/8	7½	C-20	¼	1¼	10½

Material: Highspeed Steel

The Eng. Magazine

EXAMPLES OF STANDARDIZED SHAPES OF TOOLS FOR USE IN VARIOUS MACHINES.

Showing the method of ordering by symbol number. The tools are made from carefully prepared templets, giving exact angles, clearance, etc., both in forging and grinding.

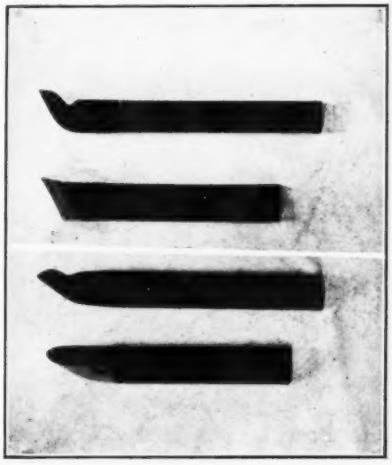


PILE OF OLD AIR-HARDENING AND CARBON-STEEL TOOLS, SCRAPPED IN FAVOR OF ALLOY STEEL.

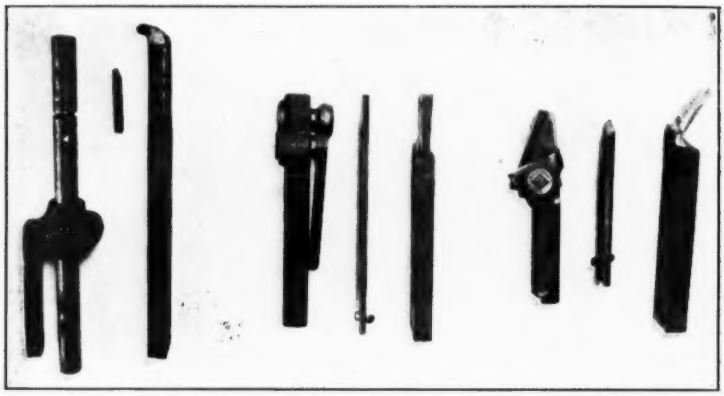
current efforts should be made with regard to equipping the machines with such steady rests, angle plates, special bolts, dogs, chucks and the like, air hoists and clamps, as will benefit the character of the work on each machine, and also the cutting tools should be standardized and the machines well provided with them.

High-speed steel will of course be very extensively used. As the capabilities of these new steels are not fully understood by some of the men when they are first brought into the shops, there is some difficulty in getting them to dispense with their old tools. A way to enforce the use of the rapid reduction tools is to scrap, or take out of service, every old tool.

The illustration shows an example of standardized tools. The diamond-pointed, curved, gooseneck shape, weak and unsupported where it should be strongest and best supported, was very common in our shops, and a standard style five years ago. In fact, at the present day this tool may be seen in use in many shops.



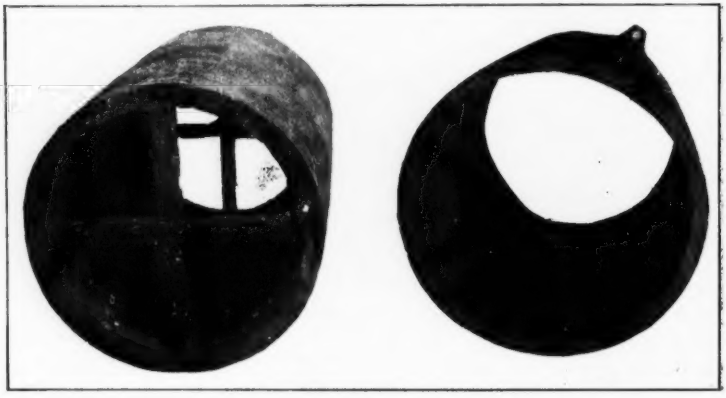
OLD AND NEW STYLE LATHE TOOLS.



TOOL HOLDERS FOR USE IN ECONOMIZING STEEL.

Recently I noted in passing through the instruction shop of an engineering college that the young men were being taught to forge and grind their tools in this way. In contrast to this poor design, note the modern design of round nose, most efficient in cutting action, enabling a large chip to be removed, and well supported by the tool post.

By means of these general machine improvements alone, which with intelligent direction will not increase the cost of the tool account at all, but will, in fact, enable it to be reduced even while these wholesale improvements are being carried forward, a great increase in shop efficiency will result, without stirring up any labor difficulty.

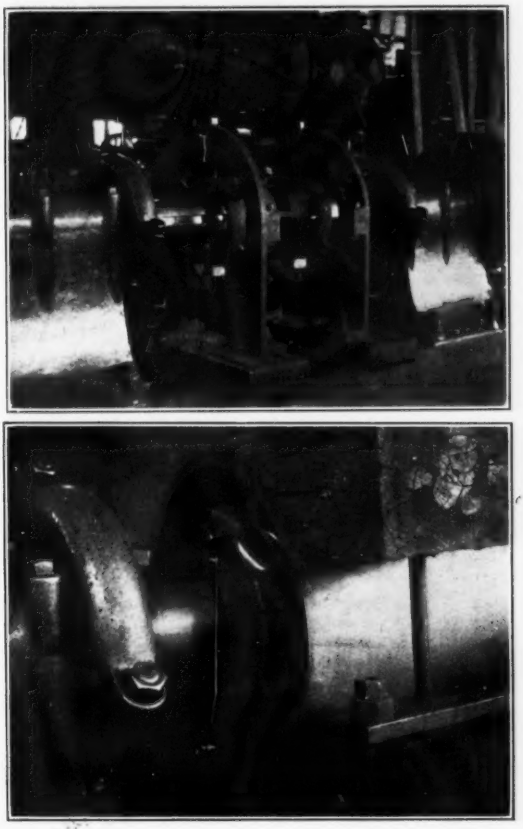


CYLINDER BUSHING, OLD AND NEW PATTERN.

A detail example of machine redesign is here given.

The lower picture, page 188, shows on the left the old method of supplying cylinder bushings. The casting is much too heavy, and the cross arms, made so that the bushing could be centered in a lathe and turned off previous to boring, were quite difficult to cast. The bushing on the right is much cheaper to make.

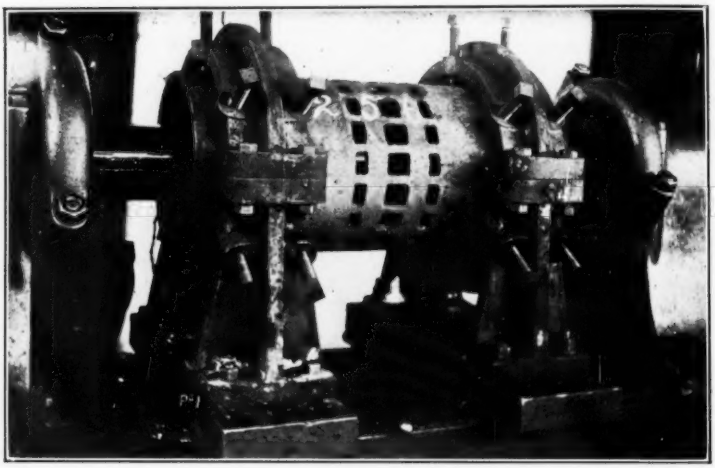
The lower cut on this page shows the old method of housing a bushing after it had been turned in the lathe so it can be bored in a horizontal mill. This large wooden block, for use with each size of bushing, is a very clumsy and unsatisfactory contrivance. The housing with set screws shown above was therefore devised and gave good satisfaction, as the work could be accurately centered for boring and then mounted on a mandrel and turned up in a lathe. So soon, however, as high-speed steel tools were used in the horizontal boring mill it was found that this new housing was not sufficiently rigid and a more substantial one was designed, which stood up to all the requirements.



OLD AND NEW DESIGNS OF HOUSING.

The clumsy wooden block, shown below, is replaced by the housing with set screws, above.

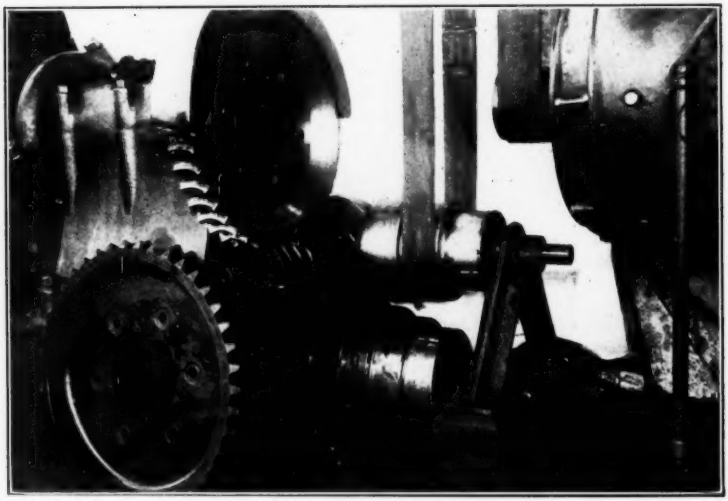
Then, however, the strain on the machine was so great that the



THE REDESIGNED HOUSING, IN DETAIL.

belt would not pull the cut that the tool was able to stand and a heavier and wider belt had to be provided. In order to use the wide belt, the four-cone pulley was displaced and a three-cone substituted.

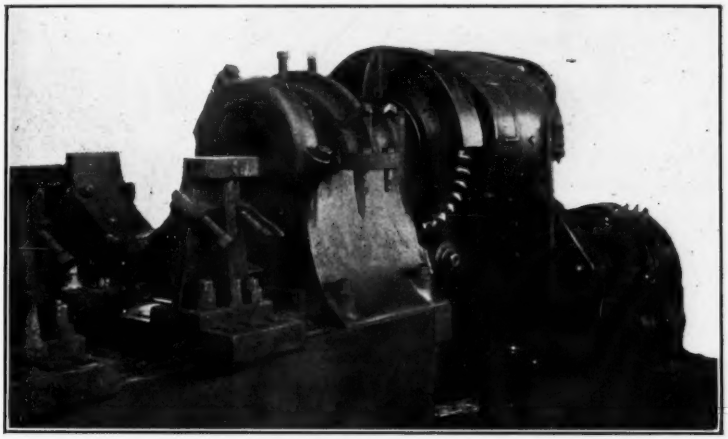
It was found that the cast-iron worm gear ran hot under these heavy cuts and a bronze gear was made to take its place. The cast-



BRONZE WORM GEAR FOR HEAVY SERVICE.

iron gear is shown in the lower left-hand of the picture, the bronze gear up in place. When the machine was thus redesigned for use in heavy work it developed that the electric motor was not sufficiently powerful for the purpose and one of twice the horse power had to be then put in place. This displaced motor is shown on the floor.

This series of improvements resulted in a much better machine than could be bought upon the open market, and they cost less than a new machine built to order by any outside manufacturing concern.

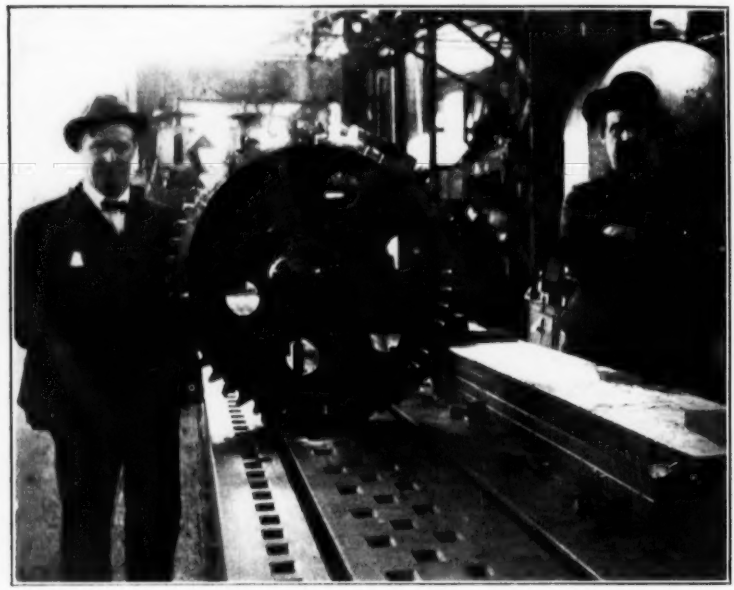


A RECONSTRUCTED MACHINE, WITH POTENTIAL POWER DOUBLE THAT OF THE OLD.

Speaking of high-speed tools: it soon becomes evident when these heavy service tools are introduced in a shop, that many, in fact most, of the machines are not up to the capacity of the tools. Line shafts are speeded up, and driving pulleys enlarged. It is then found that the feeds, too, must be increased, to take full advantage of the cutting qualities of the new tools.

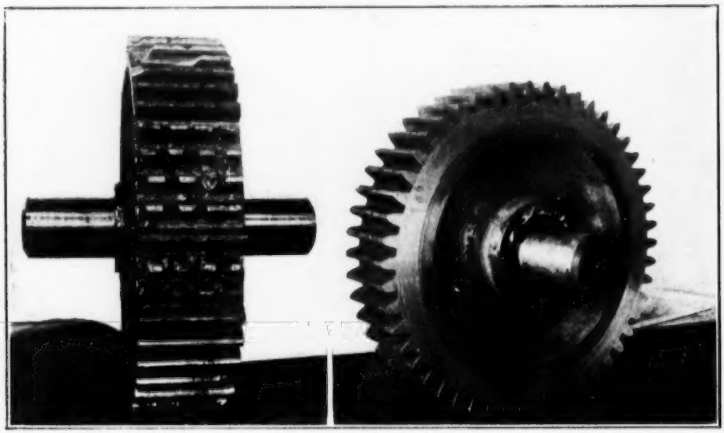
Page 192 shows a large frame planer. When this machine was speeded up, and heavy cuts taken with high-speed tools, the driving gear stripped off a tooth at one time or another. Teeth were in some cases inserted, as shown in white on this picture, and in other cases pegs were tapped in. It was finally decided to put in a steel gear, but as it would have taken several months to send to the foundry and secure a steel casting as required, a cast-iron center was hurriedly ordered and a steel band forged in the smith shop, and machined and shrunk as shown at the foot of the next page.

The picture, page 193, shows the substitution of a large for a small



A LARGE FRAME PLANER, AND ITS OLD CAST-IRON DRIVING GEAR.

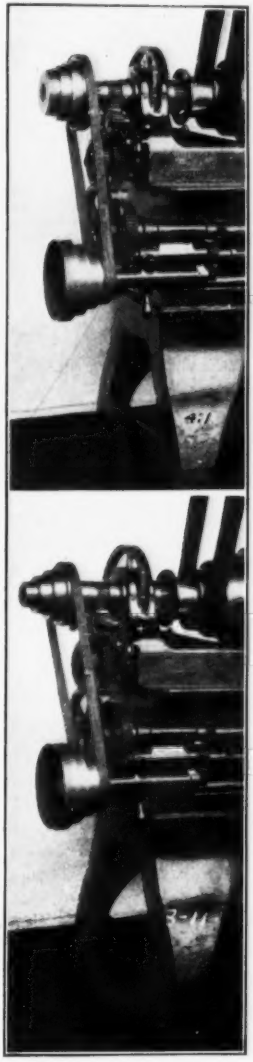
feed cone pulley on a bolt lathe in order to increase the feeds in addition to the speed. When it is remembered that the main line-shaft of



THE OLD GEAR OF THE PLANER ABOVE, AND THE NEW STEEL-RIMMED ONE.

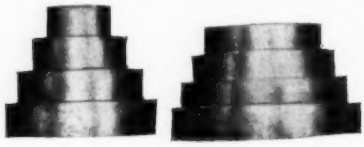
the shop was speeded up 50 per cent, and the pulley driving the countershaft for this particular lathe 30 per cent in addition, upon the introduction of high-speed steels in this shop, the additional rapidity incident to the use of this feed cone pulley will be appreciated.

In the early stages of the development of the high-speed alloy-steel tools, it was realized that the physical properties of these steels, in affording material for tools capable of greater cutting speeds, feeds, and cuts, would react upon the machine tools themselves and, in the case of new machines, necessitate improved design and adaptation to the new conditions; in the case of old machines, requiring redesign of some parts and reconstruction. Of course with the new steels greater strains are encountered than those for which the machines had been designed. Now it is a fact that so far there have been very few recently designed machines turned out by the manufacturers which are altogether adapted and suitable for use with these new tools, notwithstanding the very pertinent observations and suggestions of Mr. Oberlin Smith and of the early users and advocates of the new steels. Besides this condition, the original commercial machines, when put into a railroad shop, are not always suited to the work they are to do. A gang drill will be strongly advocated by some agent on account of the speed with which it can do certain classes of work, and the master mechanic or other officer having charge of the local shop, being much impressed with the argument, will ask for such a machine on his budget, unmindful of the fact that the classes of work on which this machine can be eco-



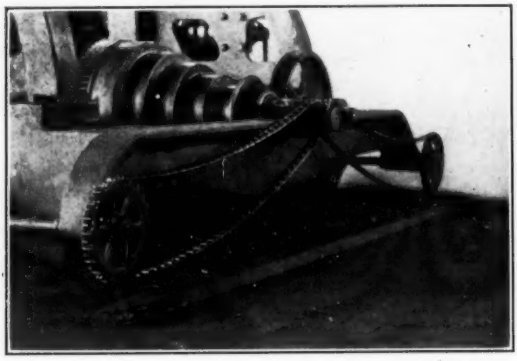
FEED-CONE-PULLEY INCREASE ON A BOLT LATHE, TO USE HIGH SPEED TOOLS.

nomically used will not occur more than once or twice a month. Had the money thus invested been spent for a thoroughly substantial and modern radial drill, or for general improvements and repair of all of the rest of the shop drilling equipment, much larger returns in economies of shop production would have resulted. Of course I do not mean to say that in a very large centralized railroad shop a gang drill would not be a useful and a profitable acquisition. I am referring to the usual railroad back shop.

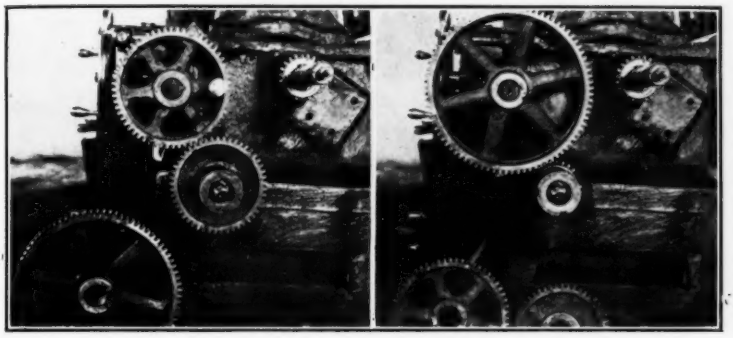


COMPARATIVE SIZES OF OLD AND NEW LATHE-FEED PULLEYS (SEE PAGE 193).

Another instance of a special tool supposed to be of great economy is that of a large hydraulic flanging press and adjacent annealing furnace, purchased with the intention of pressing, from the steel plate, throat sheets, door sheets, fire-doors or fire-door flanges, front-end rings and front-end doors, cylinder-head casings, and even steam-dome flanges from 1-½ inch metal. For each of these different parts separate dies or formers have to be made, these being manifold in number for each of the principal classes of locomotives in service, and furnace, an investment of $30,000 to $40,000 was sunk in these various formers. To set the machine up for flanging or pressing out any article required from two to ten hours' time of a skilled mechanic, helper, and a couple of laborers, beside the services of a gang of laborers to bring the heavy formers into the shop from their storage place. Once the machine was set up of course the flanging would be done quite rapidly, and with relatively few, though skilled, men. But when



DIRECT CHAIN DRIVE ON A BORING MILL. A SMALL MACHINE IMPROVEMENT.



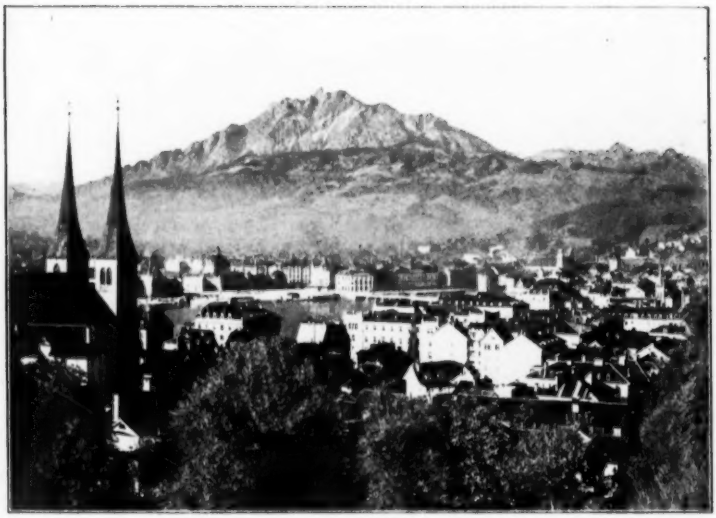
INCREASE IN SIZE OF FEED GEAR ON AN AXLE LATHE.

Due to increased feed possible with the new alloy steels. This is one of many ways in which old machines may be rebuilt to meet the new conditions.

it is considered that (1) these large articles are not usually required in quantity, (2) the formers often crack and new ones have to be made, and in any case are very difficult to adjust, and (3) above all, that a sum not far from $50,000, meaning an interest charge (at 6 per cent) of a dollar for every work hour in the year, not to speak of cost of power consumed and various repair charges to the machines themselves—it will be seen that for even a large centralized railroad shop the old fashioned gang of boiler-maker flangers with their wooden flanging mallets and simple slab formers, in addition perhaps to a modern oil annealing furnace, would be much more economical.

I have cited these two cases simply as an illustration of the point that fitness to the product in view is not the ruling motive of the sellers of machine equipment. What I wish at this point further to develop, however, is, that such fitness can be secured with very great economy in regard to fixed or over charges, by intelligent and systematic redesign, by partial reconstruction, and by increasing the speed and capacity of the old tool equipment. It may be confidently asserted that there is scarcely a railroad in the country which does not possess nearly twice the number of machine tools that it actually needs to keep up its power and rolling equipment, provided these tools were properly "balanced" with reference to one shop and another, and used with the object of getting the utmost from their investments.

If this reformation of tool equipment is followed up by some system of rewarding labor according to individual effort, or some other financial incentive toward time reduction in machining and other operations, full benefit from these improvements will speedily result.



LUCERNE, WITH MT. PILATUS IN THE BACKGROUND.

A MODERN SWISS HYDRO-ELECTRIC POWER STATION.

By Enrico Bignami.

If the traveler, leaving the highroad of Engelberg, passes behind the ancient convent and crosses the meadows sloping to the River Aa, he may hear on every side the rippling of brooks—springs of sparkling, crystalline water leaping from the ground, soon to unite their threads in a stream of some size. This is the Erlenbach, whose waters, near their source, maintain almost an even temperature throughout the year. It carries no sand nor gravel, and—most important for Lucerne—the volume of its flow never falls except in the winter. In this city of visitors, summer is the season of the greatest activity; the Obermatt station, built to utilize this source of hydraulic power, therefore carries its maximum load at the very season when the flow of the Erlenbach is most amply sufficient. The conditions for supplying power to a city like Lucerne could not be more nearly ideal.

The available difference of level between the plateau of Engelberg and Obermatt is about 312 metres; the maximum discharge is 1,000 litres per second; by well designed storage, and assuming a maximum load during twelve hours each day (which is never actually demanded in similar installations), it is possible to sell at least 6,000 horse power, and more often 8,000 to 10,000. The power output can be still further enlarged by utilizing other streams; it is therefore safe to suppose that the installation will suffice, for many years, for all the needs of Lucerne.

Not far from the point of confluence of its several sources, the Erlenbach is diverted through a canal 90 metres long to a storage reservoir of 70,000 cubic-metres capacity, serving to maintain constancy of level. A conduit 2,567 metres long at a slope of 0.12 per cent and with a free section of 4.2 square metres conducts the water thence to a small reservoir with a bottom section 7 metres square;

THE POWER STATION AND PENSTOCKS.

here are located the waste-water gates and the head gates of the penstocks. These follow the slope of the mountain to the turbine station of Obermatt and have a total length of about 620 metres; so far two tubes have been put in place, each of 1 metre sectional area, built of steel plates 8 metres in length with rivetted joints. The plans provide for two additional tubes when the installation is enlarged. The penstocks are anchored at five points by massive concrete structures. At

ENGELBERG.

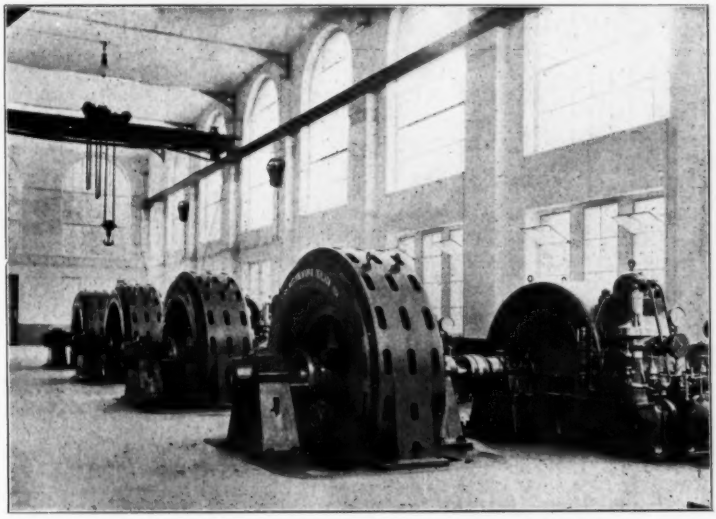
the lower end are installed the regulating valves, emptying valves, and guard plates. The tail race is of masonry, 270 metres long, and runs to the River Aa.

The narrow valley of erosion in which this stream rushes from the heights of Engelberg, opens out at Obermatt into a pleasant, protected valley. On the left are the barren slopes of the Wallen-Stöcke; over the foot peers the ridge of the Hanghorn; on the right are the sheer cliffs of the Salistock. In the midst of this magnificent scenery, just where the stiff grade of the Engelberg railway begins, is built the power station. It looks like a modern castle, with its walls of masssive stone, its full arched windows, its crenellated façade, and its escutcheon bearing the arms of Lucerne and Unterwalden. The architecture suggests a complete accord between the building and its surroundings, the gray limestone masonry standing picturesquely against

the green background of forest and pasture, and the simplicity of the lines harmonizing with a region of mountain and woodland.

The station is divided into three principal parts—machinery room, switching room, and transformer room; in addition there is a section for an accumulator battery and a suite of waiting rooms, baths, etc.

The machinery room is large, well lighted, 54 metres long by 13 in width and 12 in height; it is designed for six units of 2,000 horse power each; so far but four are installed. Between this room and the switching room is a wall with five masonry pillars and arched openings, the lower part filled with ribbed glass. Up to the height of the window sills the walls are tiled in a green glazed faience, giving the room a very cheerful air. A 13-ton electric crane covers the whole machinery floor.

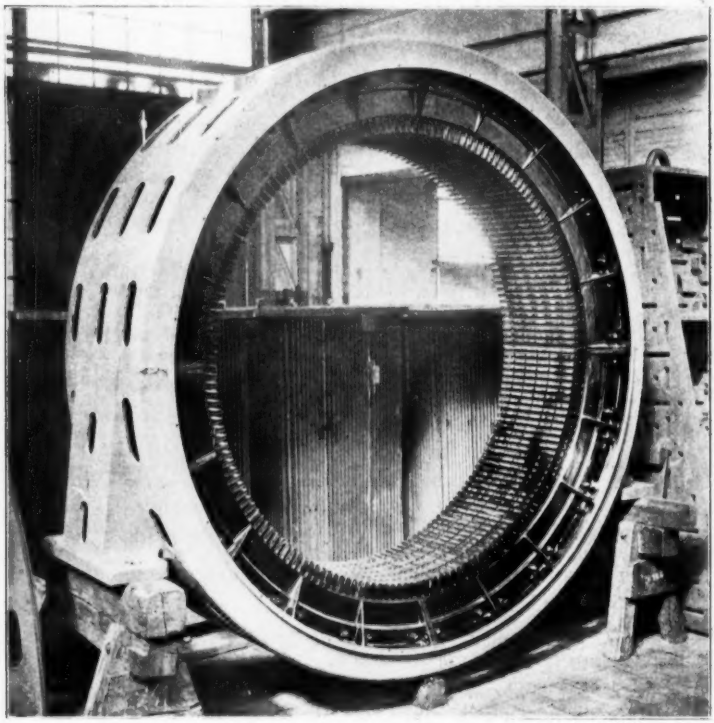


DYNAMO ROOM IN THE OBERMATT POWER STATION.

The wheels are of Pelton type, arranged for regulation by hand as well as automatically, and operated by a hydraulic servomotor. They are of 2,000 horse power each, with a head of 312 metres and at 300 revolutions a minute. The hydraulic machinery was supplied by Th. Bell & Cie., of Kriens, and the electric by the Oerlikon works.

The station supplies lighting and power current to Lucerne, 28 kilometres distant, about 200 kilowatts for power and light in the commune of Engelberg, and another 200 kilowatts used in a dozen localities in Nid- and Oberwalden. The conditions in Lucerne de-

manded the most perfect and regular lighting service obtainable, indicating the use of single-phase current. Two separate systems of bus bars and two distinct services were therefore combined in the installation—single-phase current for the Lucerne lighting service, and three-phase for the rest. The four 2,000-kilowatt double-current alternators feed either lighting or power service. An alternator provided for the Stanstad-Engelberg railway is absolutely separated electrically from the rest of the installation, except in the matter of excitation. This is effected for all the alternators by a group of two 100-kilowatt continuous-current dynamos driven by special turbines, either one being sufficient for exciting the five alternators, the second being a reserve. The lighting circuits of the station and also those operating the many automatic switches and magneto-signals are taken from the exciter bus bars. A battery of accumulators is also installed.



STATOR OF A 2,000-HORSE-POWER ALTERNATOR IN CONSTRUCTION.

The alternators are provided with overload oil switches and the connecting rings are designed to be operated without current. The bus bars form a closed collector ring and are installed in a separate compartment.

The feeder cable of the Engelberg division takes current direct from the bus bars at 6,000 volts, as well as the primary circuits of the transformers, which raise the current to high tension at 27,000 volts, which are the two standards used. Of the ten single-phase transformers, three are used on the Lucerne lighting circuit, while the other seven take care of the Lucerne power circuit and of the Ober- and Nidwalden service. Six of these are connected up in triangular groups of three each, forming two separate tri-phase sets, while the seventh is kept in reserve, to be connected up as required, between any two phases of either group.

Each transformer carries on both its primary and secondary side, an overload oil switch with time relays.

The high-tension bus bars, or 27,000 volt two-ring collectors, feed directly three 3-wire lines—one for the light and one for the power circuits of Lucerne, and one for the combined light and power service of Unterwalden. The lines as well as the generators can be used for either service, light or power. Special section switches make it possible to use any two wires of a line as a lighting circuit, leaving the third wire in reserve. The lines are protected against atmospheric discharges and overloads by induction coils and by lightning arresters of the double horn pattern, combined with liquid resistances.

The following description and ratings of the electrical machinery and equipment may be of interest:

Alternators.

Power consumed .	2,000	horse power
Electrical energy	1,380	kilowatt three-phase current
	1,850	kilowatt single-phase current
Pressure	6,000	volts
Frequency	50	cycles
Speed	300	revolutions
Total weight	36,000	kilogrammes
Excitation at	100	volts

These machines are of the alternate-pole type, with fixed armature windings, and a revolving inductor on a horizontal shaft, direct-connected to the turbine. The main ring, which is cast in four sections, is bolted to the foundation plate. The armature fastens on the inside of the main-ring casting and is held in place by two steel ex-

panding rings. The armature coils fit in slotted grooves with micanite insulation, held down by hard fibre keys. There are nine armature coils per phase, and the windings are connected on the star system. The construction of the armature makes it easy to remove and replace a defective coil without unmounting the whole machine.

The inductor consists of a wheel formed of four steel rings carried on double cross arms key-seated to the shaft and provided with twenty pole projections. The spaces between the four rings that form the rim correspond with the ventilating holes of the armature.

The pole pieces are built of laminated iron in four sections of unequal size, presenting in cross-section, the appearance of a four-stepped truncated pyramid; which construction is found to give an almost sinusoidal voltage curve.

Exciters.

Power consumed	150 horse power
Electrical rating	100 kilowatts
Normal voltage	100 volts
Maximum voltage	150 volts
Speed	700 revolutions
Weight	3,500 kilogrammes

These are regular six-pole, shunt-wound dynamos with armature drum winding in parallel. The coils are bound down in the armature-core grooves with wire bands. The commutator has 170 copper segments, and the current is collected by carbon brushes.

The storage battery is composed of 56 cells with a total capacity of 1,000 ampere hours, with a maximum intensity of 1,000 amperes for one hour, or an intensity of 1,500 amperes for fifteen minutes. The cells are arranged in three rows, and the ceiling has been covered with a coat of gray enamel in order to protect the Siegwart reinforced-concrete beams.

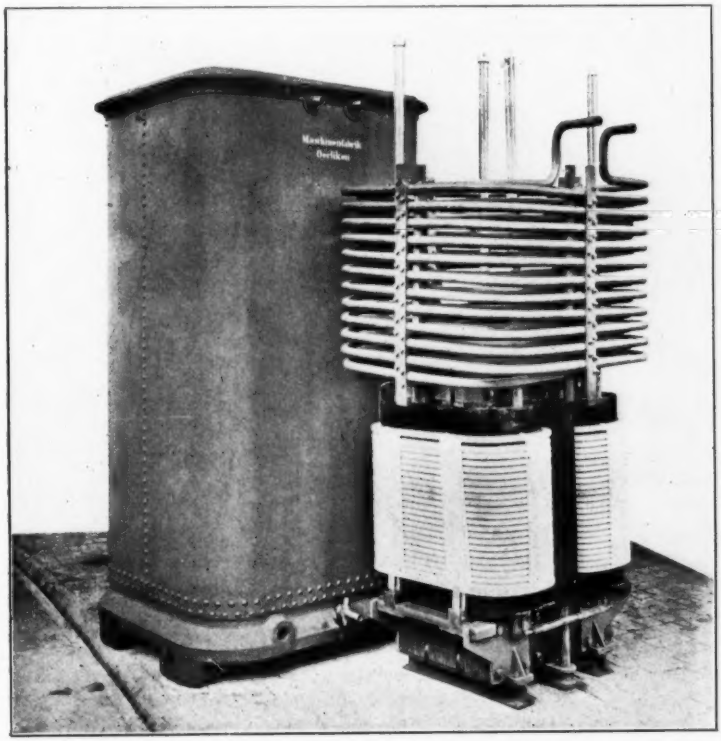
An interesting feature of the plant is the remote-control, motor-operated, cell-charging device. A double-throw switch lever starts the motor, which runs on a direct current, revolving in the desired direction, and an automatic device shifts connections so as to keep the voltage constant during the charge and discharge of the battery, which operations are all recorded on indicators mounted on the accumulator and switchboards.

Transformers—Particular care has been taken with the installation of the transformers. They are contained in a structure separate from the main station, directly adjoining it. They are of the type known as water-cooled, single-phase, oil transformers. Each

is placed in an individual fireproof compartment closed in with iron shutters, and mounted on a base or platform running on rails, which facilitates moving them. They are rated as follows:

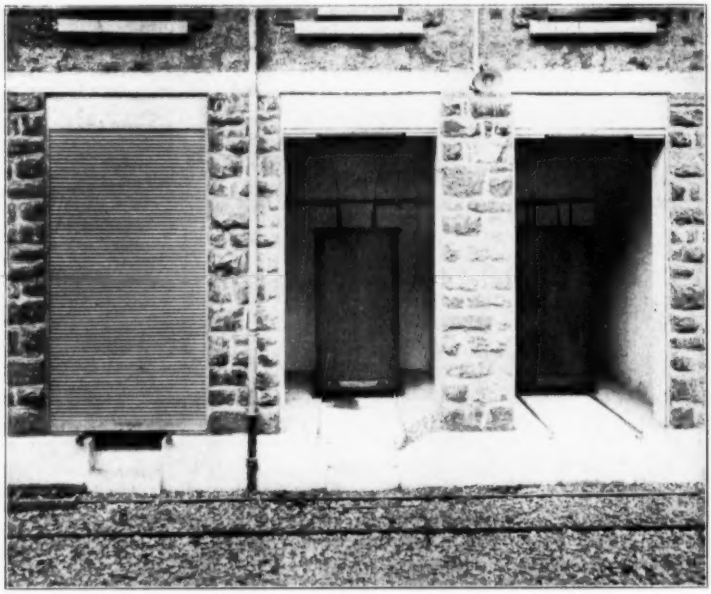
Electrical capacity	700	kilowatts.
Primary tension	6,000	volts.
Secondary tension	27,000	"
Ratio of transformation	1 : 4.5	
Frequency	50	
Weight without oil	5,500	kilogrammes.
Weight with oil	7,500	"

The transformer cases are built of sheet iron, and contain the oil which is cooled by a double worm tube having a high-speed water circulation.



700-KILOWATT THREE-PHASE TRANSFORMER.

The core consists of two vertical rectangular plates held together at top and bottom by short sheet-iron clamps, which design, while minimizing core losses, presents a very large cooling surface. The primary windings are placed next to the core, and consist of flat copper wound spirally in successive coils, each insulated from its neighbor by a layer of insulating board, and kept at the proper distance from the metal cores by means of thin wooden uprights placed in the boxes for that purpose. The location of the primary windings next to the core greatly increases the overload capacity of the transformer.



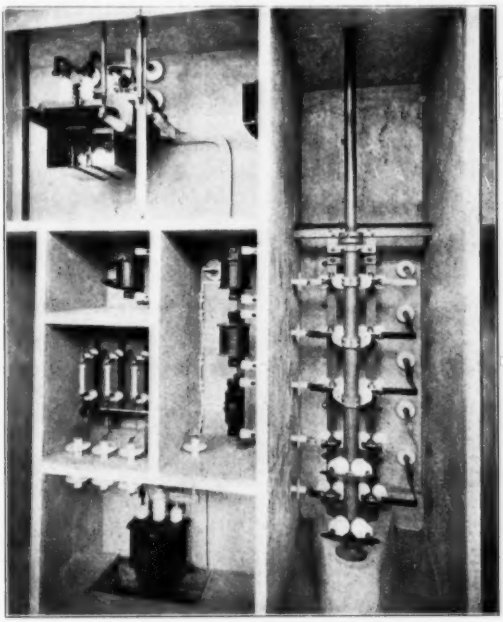
INTERIOR AND EXTERIOR OF THE TRANSFORMER COMPARTMENTS.

The high-tension coils are placed towards the outside of the boxes, and separated from the primary windings by means of a cylindrical mantle made of waterproof paper with mica insulation about 10 millimetres thick, which extends sufficiently far above and below the coils to prevent sparking even at an over-voltage of once and a half normal pressure. The complete isolation of the high and low-tension windings allows of the easy replacing of any damaged coil.

Switching Room—One of the noticeable features of recent cen-

tral-station designing is the allotting of almost as much space to the switching room as to the machinery room. The entire installation is planned on the compartment system. All dividing walls are built of reinforced concrete as well as floors and ceilings where the "Siegwart" beams have been adopted exclusively.

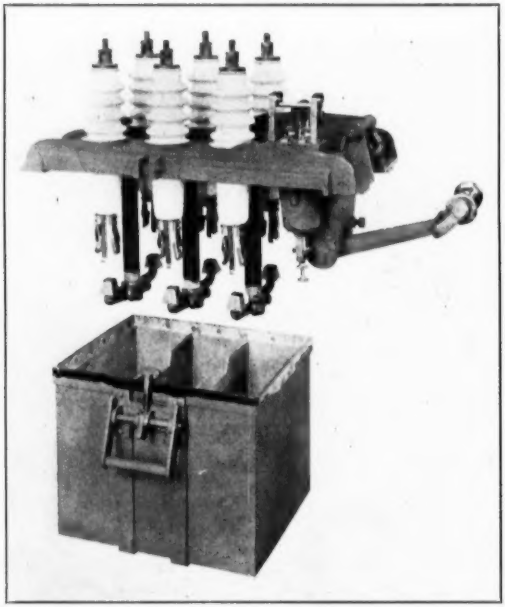
The alternating machinery, the exciting apparatus, the primary bus bars, and the primary transformer switches are located on the ground floor; on the next are the secondary switches for the transformers, the high-tension bus bars, and the main switchboard; and in the tower are mounted the line switches, and lightning arresters.



BACK OF SWITCHBOARD PANEL OF A 2,000-HORSE-POWER ALTERNATOR.

Connections from the generating apparatus to the distributing board are made by insulated cables, laid in underground conduits carried the whole length of the machinery room.

The switching apparatus controlling the alternators, the exciters, and the accumulator battery is mounted on the ground floor next to the machinery room. The first panel of the board is reserved for the generating unit of the Engelberg railroad, and is equipped with an automatic oil-switch, an overload circuit breaker, and synchronizers to throw the circuit in parallel with the central traction circuit. The next four panels operate the 2,000 horse-power alternators. Each panel is equipped with an automatic oil-switch (see page 206), a voltage transformer, four series transformers, (one



AUTOMATIC OIL SWITCH, 6,000 VOLTS.

for the ammeter, one for the wattmeter, and two for the releasing coil of the overload switch) and a commutating switch to throw the generator on either the light or power circuit. Other panels take the overload switches of the two battery exciters and the operating levers for charging and discharging the accumulators.

On an intermediate floor reached by a staircase and separated from the last described apparatus by a concrete floor, are located the shunt regulators of the exciters, and the rheostats for the excitation circuits of the alternators.

As now installed, the low-tension bus bars, from which the primary lines of the transformers and the Engelberg cable take their current at 6,000 volts, occupy a central location on the ground floor, although as originally laid out, both the high and the low-tension bus bar systems took up the whole length of the building.

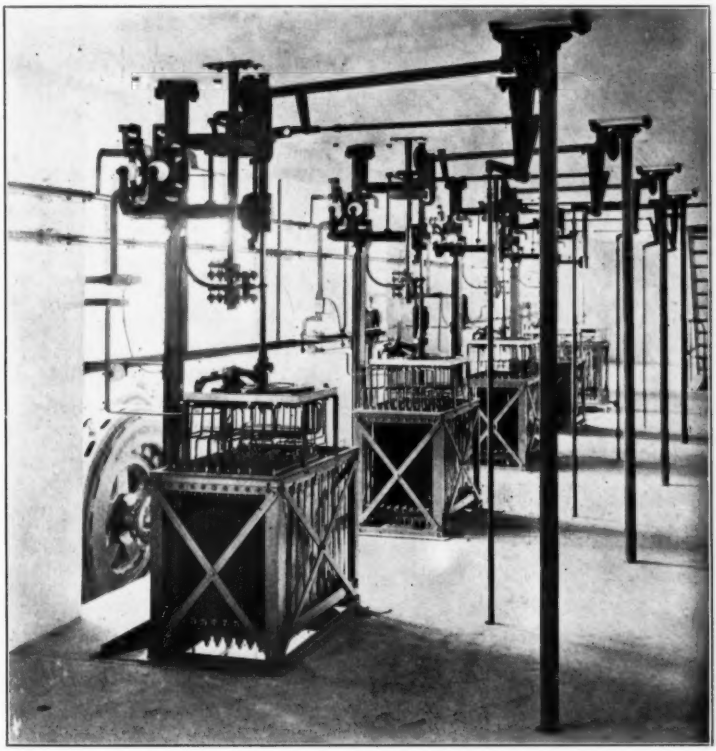
Oil switches are mounted between the alternators as well as between the two primary feeder lines of the transformers. In addition, section switches are provided on either side of the oil-switches, to cut out any desired section of the bus bars or the switch itself.

The primary transformer switches are controlled from the transformer room itself, on the ground floor, and the secondary switches are immediately overhead on the first floor, and so connected that the transformers can be thrown out of circuit from either floor. Both sets of switches are provided with time relays, and signal lamps and bells. Each transformer or group has its ammeter,

signal lamps, and time relays mounted on an individual little board next to the corresponding switch lever.

The high-tension bus-bar compartment on the first floor is similar to that of the low-tension bars on the ground floor, only the section switches here used have spring contacts and each switch is separated off from its neighbor by a concrete barrier.

Owing to the frequency of storms in Switzerland, special care has been taken to protect the plant against lightning. For this purpose, Siemens arresters of the double horn pattern have been adopted as standards, in combination with water resistances and induction resistance coils connected in series. In addition, as a protection against sudden over-voltages, each pole is kept constantly grounded by means of liquid resistances.

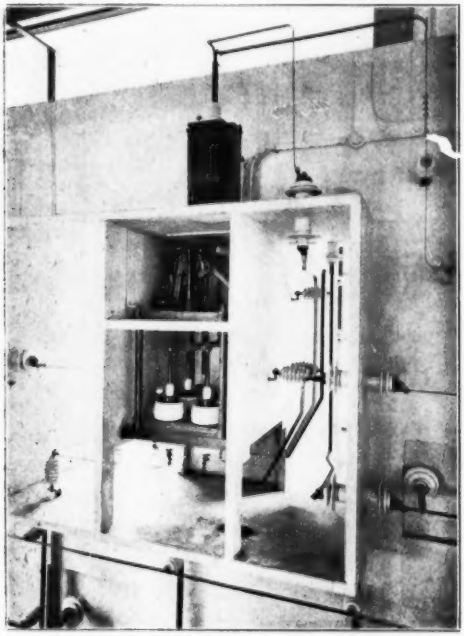


RHEOSTATS FOR THE EXCITATION CIRCUITS.

In spite of the apparently intricate wiring layout, the system of control and distribution has been centralized in the simplest and most practical manner. As described, the main operating board occupies one end of the building on the first floor. Oerlikon switchboard instruments are mostly used.

The alternator board is equipped with a wattmeter, an ammeter, a double voltmeter with two dials, the one recording the voltage at the machines, the other being a phase voltmeter for operating in parallel, and the different levers and handles controlling the starters, circuit breakers, commutating switches, rheostats and the carbon switches for the exciters.

As an additional protection against false manœuvres, a compensating or checking system is in operation. The fluctuations of the voltmeters and wattmeters of course follow the movements of the bus bar commutator, and the throwing in or out of circuit is recorded by the white or red signal lamp, in addition to the automatic ringing of the alarm bell.



SWITCH FOR 27,000-VOLT CIRCUIT, INSTALLED IN ITS COMPARTMENT.

The apparatus carried on the battery panel consists of two ammeters, one voltmeter and its commutating switch, (to read the voltages at the bus bars or at the cells during charge and discharge) the handles of the two automatic switches, and the push buttons operating the end cell switches and the two cell indicators.

The exciter panels are equipped with ammeters and voltmeters, a hand-wheel shunt regulator, and the operating levers for the circuit breaker and the commutating switch.

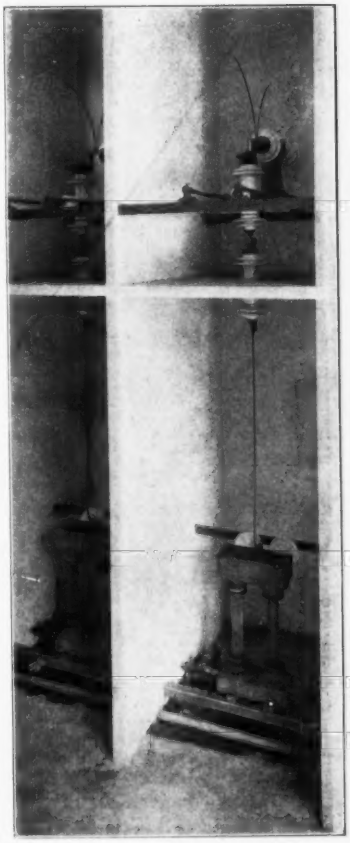
The bus bar section switches govern-

ing the power circuits are also controlled from this board.

The line connections also come in on this board. The first panel, which takes the Engelberg cable, carries three ammeters and two signal lamps. The next three panels which belong to the high-tension lines are each mounted with three ammeters, the oil-switch handles, two signal lamps and the commutating switch for the light or power circuits.

The last two panels carry the static voltmeters made by Hartmann & Braun, with condensers and graphite resistances for determining the grounds on the high-tension bus bars.

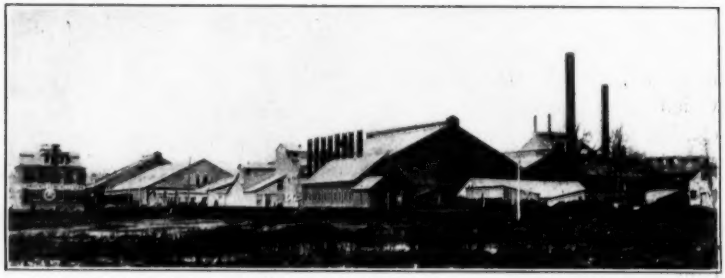
A small separate switchboard controls the lighting of the central station.



HORN LIGHTNING ARRESTER WITH LIQUID RESISTANCE.

It is just as important, for the perfect operation of the plant, that the engineer in charge of the turbines should be provided with indicating devices to enable him to handle his machinery efficiently and to regulate its speed. This arrangement consists of a phase lamp and a Westinghouse synchroscope mounted on the pedestal opposite the corresponding unit or group, in full view of the engineer when operating the turbine regulator.

The entire hydraulic installation occupied less than twenty months, and the electrical equipment was set up in less than eight. Today the plant is in full operation, and the municipality of Lucerne, which controls nine-tenths of the capital stock of the enterprise, is not only reaping most satisfactory results from an operative viewpoint of a public utility, but must be congratulated on the financial success of a public investment.



Courtesy of Robt. F. Wentz Engineering Co., Nazareth, Pa.

A MODERN MILL. PLANT OF THE LAWRENCE PORTLAND CEMENT CO., SIEGFRIED, PA.

MACHINERY AND PROCESSES FOR A PORTLAND-CEMENT PLANT.

By F. H. Lewis.

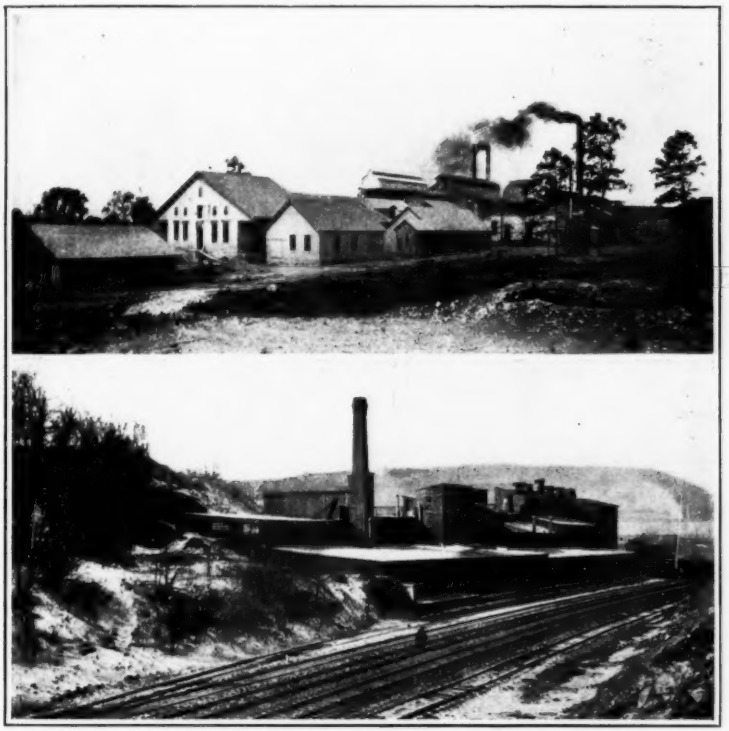
II. GRINDING BY SEPARATION.

Mr. Lewis's initial article appeared in our September issue and discussed kilns and kiln practice in connection with cement making. His study of grinding machinery and processes, now presented, will shortly be followed by a very significant review of the industrial aspects of cement manufacture, by Edwin C. Eckel, of the U. S. Geological Survey—one of the world's leading experts in this important and rapidly developing field of engineering industry.—THE EDITORS.

MAN is an imitative animal. Instinctively, what our fellows do we must try to do, with such variation and improvement as will give some suggestion of originality.

At present no matter is receiving greater attention from the technical staff of the Portland-cement factories or from the manufacturers of grinding machinery for Portland cement than the question of grinding by separation. It is extremely probable, as a result of all this investigation and experimentation which is now going on, that a method and a practice will be developed effecting important economies of manufacture and valuable returns to those manufacturers who first succeed in realizing on a large scale the advantages of grinding by separation.

I first saw a separator used as part of the grinding equipment of a Portland-cement factory in England about ten years ago. This separator was a wind separator made by Askham Bros. & Wilson, of Sheffield, Eng., and was used in the old plant of Brooks Shobridge &



EXAMPLES OF MODERN AMERICAN CEMENT PLANTS.

Above, the Phoenix Portland Cement Co., Nazareth, Pa; Below the Hercules Cement Co., Whitehall, Pa., showing Bottle Kilns. Robert F. Wentz Engineering Co.

Co. at Grays on the Thames, separating the product from buhrstone mills. The entire product of the mills was carried to this separator. The fines resulting from the separation were carried to the stock house and the coarse particles returned to the mills. In Germany at this time a similar separator made by Pfeiffer Bros. was used in quite the same way, also with reasonably satisfactory results.

In the manufacture of natural cement in America a well defined and very successful practice of grinding by separation has been in use for many years. This method has been patented by Mr. J. R. Berthelet of Milwaukee, Wis., and used very successfully at the works of the Milwaukee Cement Co. and also in certain plants of the Western Cement Co. at Louisville, Ky. The Berthelet scheme is shown by illustration Figure 1 and consists:—

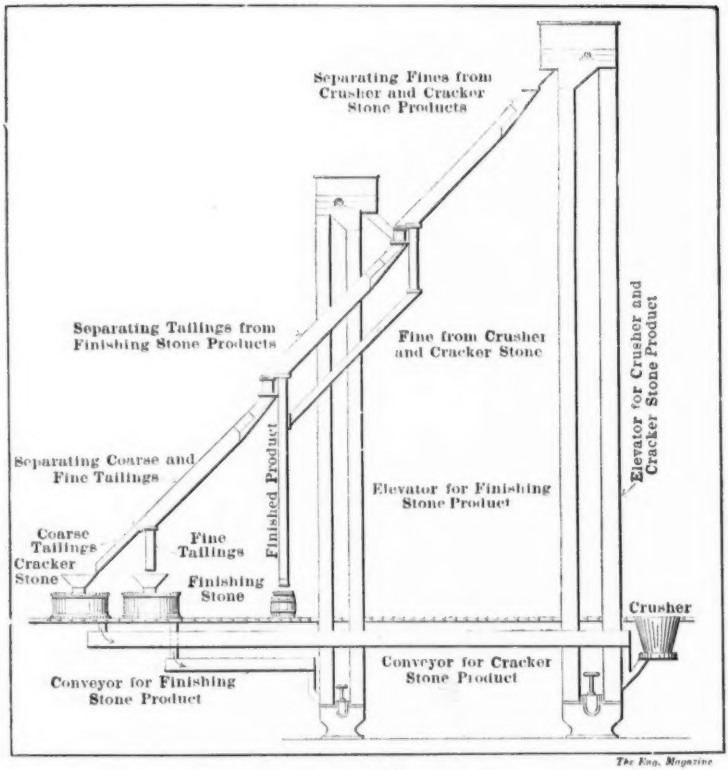

Separating Fines from Crusher and Cracker Stone Products
Separating Tailings from Finishing Stone Products
Fine from Crusher and Cracker Stone
Elevator for Crusher and Cracker Stone Product
Separating Coarse and Fine Tailings
Finished Product
Elevator for Finishing Stone Product
Coarse Tailings
Cracker Stone
Fine Tailings
Finishing Stone
Crusher
Conveyor for Cracker Stone Product
Conveyor for Finishing Stone Product
The Eng. Magazine

FIG. 1. BERTHELET'S SEPARATOR.

1. In always passing material over a screen after each step in the process of reduction, and,

2. In order to effect this separation the coarse and fine stuff always pass together over the screen.

As installed in the works of the Milwaukee Cement Co. this method of separation has shown an output of 1,500 barrels of natural cement in twenty-four hours with only one finishing buhrstone mill. But this natural cement product is only a reduction to 50-mesh fine of a soft material not much if any harder than ordinary quick-lime.

In grinding Portland cement the conditions are very much more difficult because:—

1. Both the raw material and the clinker are very much harder than the natural cement product.

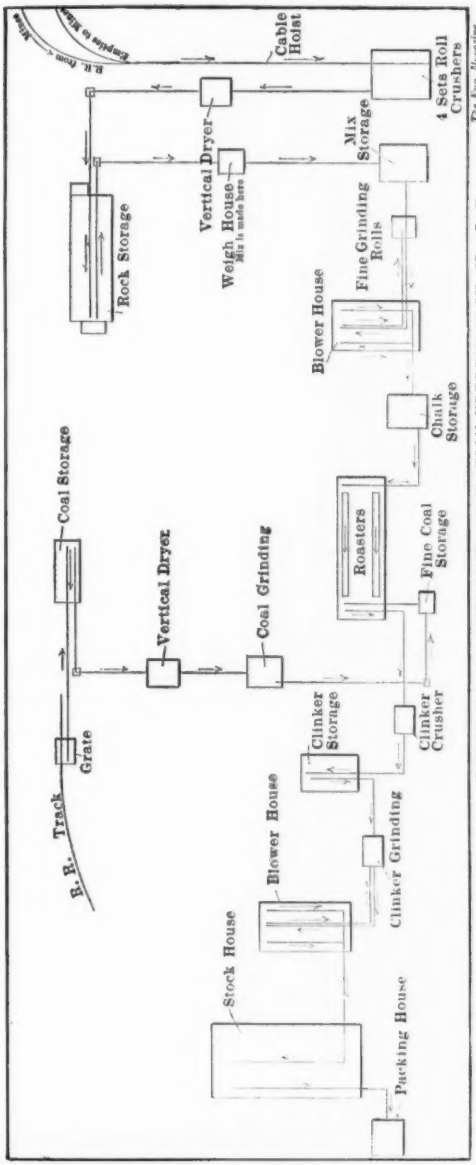


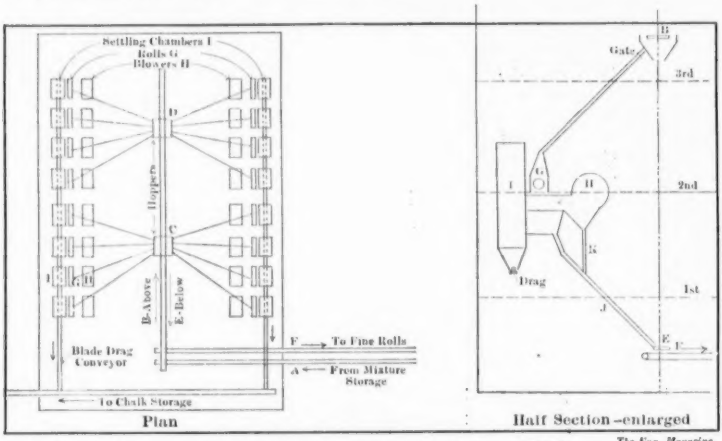
FIG. 2. GENERAL PLAN FOR EDISON CEMENT WORKS. DESIGNED BY WATSON VREDENBURGH, JR., C. E.

2 Both the raw material and the clinker must be ground much finer.

3 By reason of greater hardness the wear and tear and repairs in Portland-cement manufacture are much greater.

In America no attempt was made to grind by separation in Portland-cement manufacture until the Edison Portland-Cement Works was built at New Village, N. J., in 1901. In building this plant Mr. Edison introduced a number of novel features, and in fact almost wholly disregarded precedent and designed a plant which was unlike any Portland-cement factory either in the United States or elsewhere. Among other novelties he established a most elaborate system of grinding by separation. To what extent the system of grinding established in the Edison fac-

tory has been successful I am not informed, but there can be little doubt that the initiative taken by Mr. Edison in this factory has been suggestive to other manufacturers and the cause of extensive investigation of various methods of separation now in evidence in America.



FIGS. 3 AND 4. CEMENT PLANT AND SEPARATOR SYSTEM.

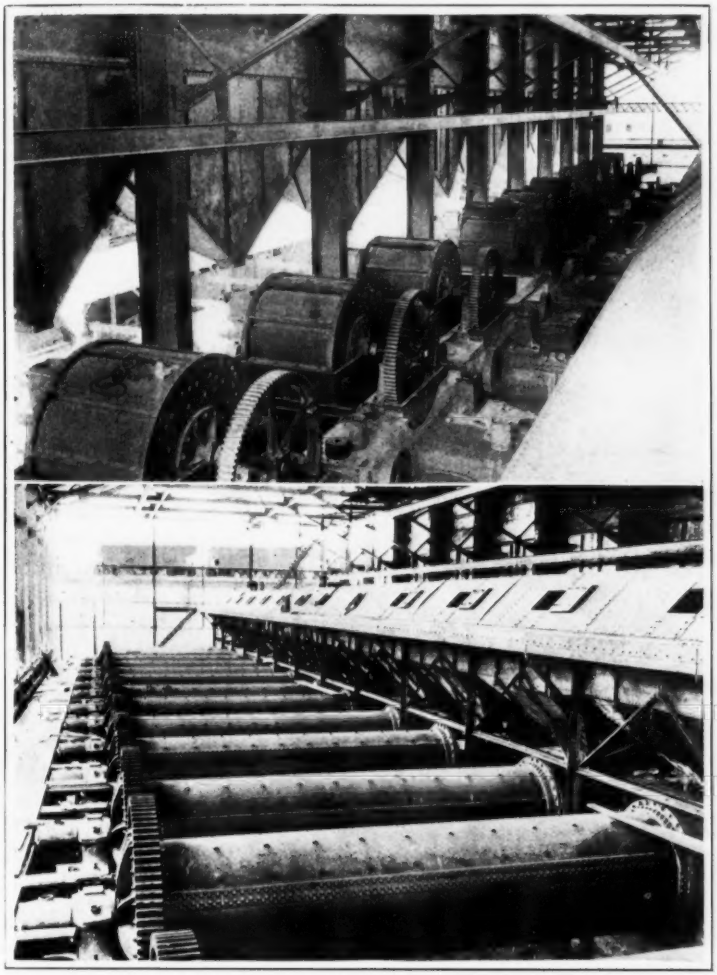
Designed by Watson Vredenburgh, Jr., C. E.

Reduced to its simplest essential features, the scheme introduced at the Edison works is shown by Figures 2 and 3 above. At the Edison works the reduction of material was performed, not in mills, but by means of rolls. As these rolls are not adapted to fine grinding they are operated in conjunction with a very extensive and elaborate system of wind separation. As shown on the cuts, the raw material, mixed in proper proportions, is carried by a belt conveyor directly to the blower house. This conveyor in passing receives the product of the fine grinding rolls, but these fine grinding rolls are fed entirely by the tailings returned from the blower house.

On the clinker end the method is rather different as the clinker passes through the rolls, thence to the blower house, the tailings being returned to the rolls.

Figure 4 shows a plan and half section of the blower house showing the general arrangement of this building and the course of the material passing through it. Such, in its general features, was the Edison separation system.

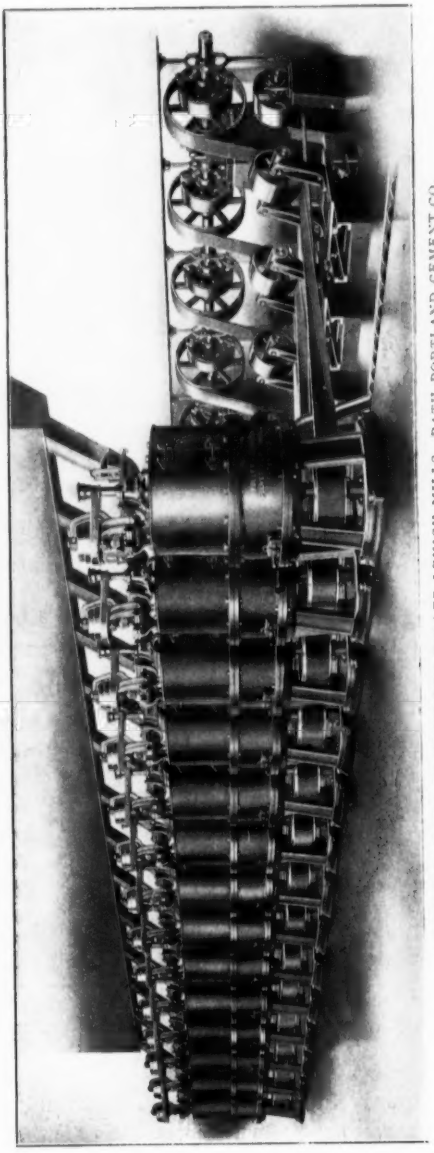
It will probably be an advantage at this point in this article to



TYPICAL EXAMPLES OF CEMENT GRINDING INSTALLATIONS.

Above, ball mills, and below, tube mills in the clinker-grinding room at the Illinois Steel Co.'s cement mill, Buffington, Ind. Both by the Allis-Chalmers Co.

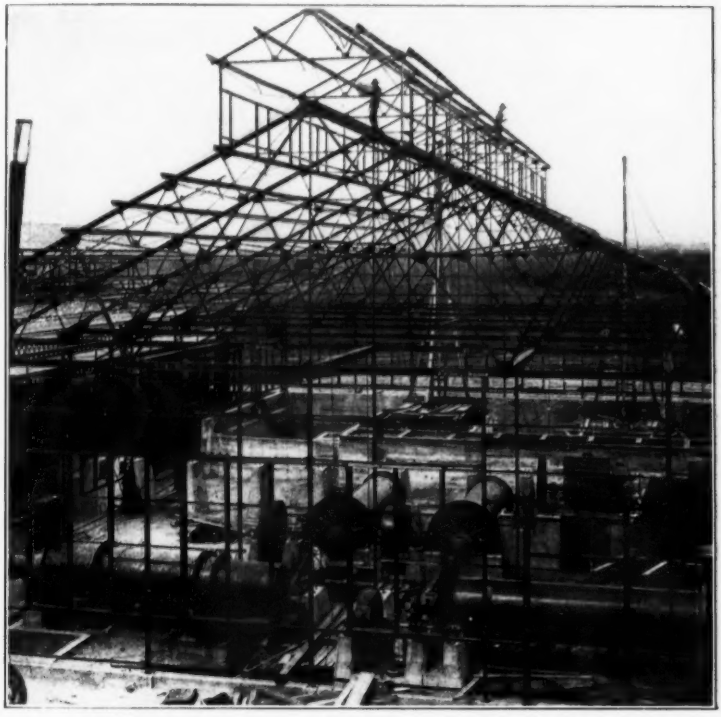
discuss the principle and the merits of separation *per se* in order that the descriptions which follow may be fully appreciated. In general it may be said that every grinding machine will yield more output if the finished product can be removed immediately as fast as it is produced. Any stuff remaining in the mill after it has been ground to the desired



AN INSTALLATION OF FOURTEEN FULLER-LEHIGH MILLS, BATH PORTLAND CEMENT CO.
The main shaft was originally installed for other machines; hence the quarter-twist belts. Lehigh Car Wheel and Axle Works, Catasauqua, Pa.

fineness remains there to the disadvantage of the output of the mill. The fine stuff constitutes a matrix in which the coarser particles are imbedded and interferes with the grinding action on this coarser stuff. Any method, therefore, which will relieve the mill of its product as fast as it is reduced will increase its efficiency and output.

Therefore if the contents of the mill could be kept in rapid circulation between the mill and a separating system which would take out the fines and return the tailings, the output would be very much larger. Taking this for granted it therefore becomes a question of balancing the first cost and operating cost of a series of mills, against the first cost and the operating cost of a

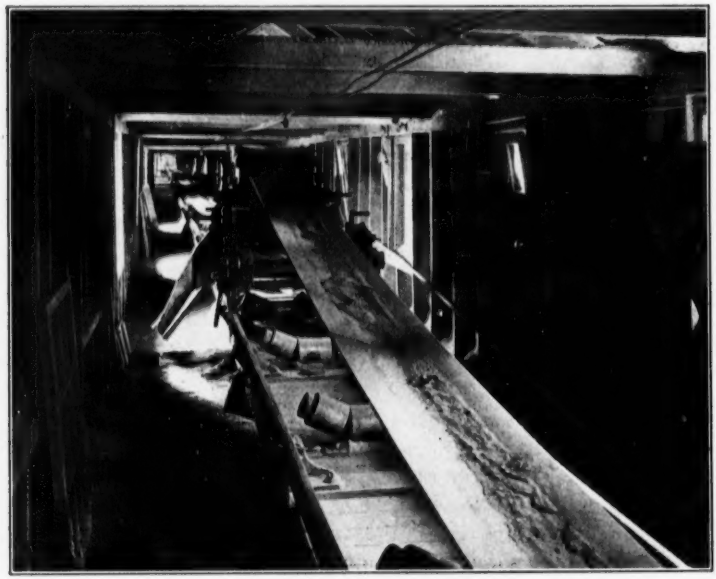


BALL AND TUBE MILLS, FARWELL PORTLAND CEMENT CO.
Robert F. Wentz Engineering Co.

smaller number of mills operated in conjunction with a system of separation.

Again, there are quite a large number of grinding machines which yield their product by passing it through screens or sieves attached directly to the machines. The ball mill is a machine of this type. It has been found very difficult, however, where fine grinding is to be done, to provide sufficient screening facilities to these mills. The product does not come out as rapidly as it is produced. The mills are more or less clogged with fines at all times. Take the particular case of a ball mill, for instance, equipped with 20-mesh screens, yielding its product through these screens and producing, say, 25 barrels an hour. Sifting this product it will be found that while all of it passes the 20-mesh screen, perhaps 50 per cent of it will pass 100-mesh screen, and in this respect the work which the ball mill has been compelled to do is unnecessary. Suppose, however, we equip this ball

KILNS AND TUBE MILLS, LAWRENCE PORTLAND-CEMENT CO.
Robert F. Wentz Engineering Co.



A CONVEYOR IN A CEMENT MILL.
Belt 13 inches by 472 feet discharging 90 tons an hour. Installed at Marquette Cement Mfg. Company's plant, La Salle, Ill., by Robins Conveying Belt Co.

mill with ⅛-inch screens, letting its product pass out much more freely and effect a separation to 20-mesh by a separator outside of the mill, returning the tailings. By doing this the mill is evidently promptly freed of its dust and fine stuff and the grinding action is entirely on coarse material. It is reasonable to suppose, therefore, under these circumstances, a much larger output will be obtained. Practically this has been demonstrated to be the case.

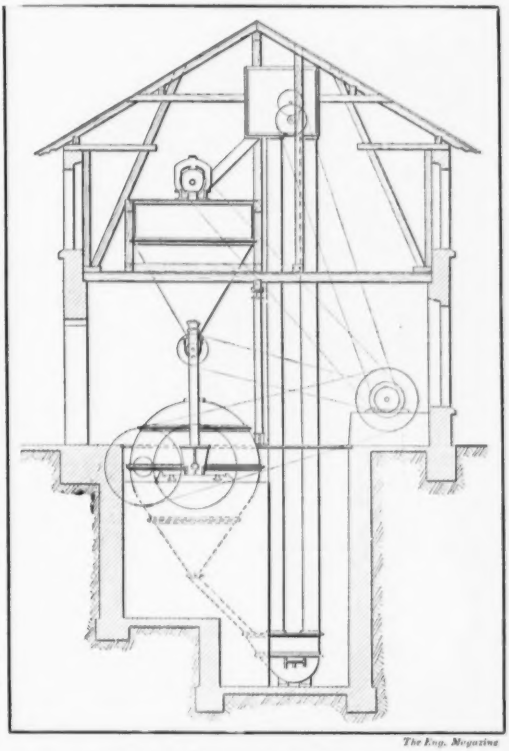


FIG. 5. BALL MILL AND SEPARATOR, PFEIFFER SYSTEM.

Again take the case of a pebble mill, which is a finishing mill required to reduce cement to a fineness of 92 per cent passing 100-mesh screen. In a mill of this kind the material passes from one end to the other, a distance of about 20 feet, subjected to the grinding action of pebbles throughout this length. The material is, therefore, becoming finer and finer as it advances through the mill, and in the vicinity of the discharge end it is probable that very little reduction is going on because what coarse stuff remains is imbedded in a matrix of fine material. Suppose, then, that we effect two separations in conjunction with this pebble mill. First we separate the feed to the mill, taking out all material which is 100-mesh fine, and then suppose that we run this mill with a very heavy feed and effect a separation to 100-

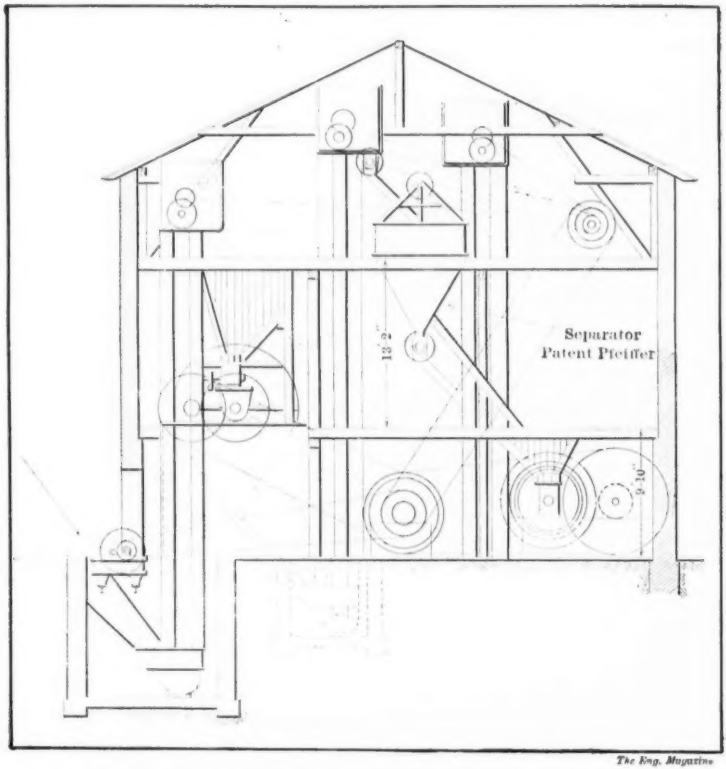


FIG. 6. SEPARATOR ARRANGEMENT FOR 10 TONS PER HOUR ELEVATION.
Gebrüder Pfeiffer, Kaiserslautern, Germany.

mesh fine of its output. The probability is that under these conditions we will show a marked gain in the yield of the mill. Meantime, however, it is evident that we have complicated this plant by separating devices at both ends of the pebble mill, including the elevating and conveying apparatus required in conjunction with separators. It becomes, therefore, a question whether we have, in final analysis, made any gain or not. That is, it is a question of first cost and cost of maintenance of a larger number of mills, as compared with first cost and cost of maintenance of a smaller number of mills working in conjunction with this separating apparatus.

In Figure 5 is shown the installation of a ball mill in conjunction with a pneumatic separator which returns the coarse and carries off

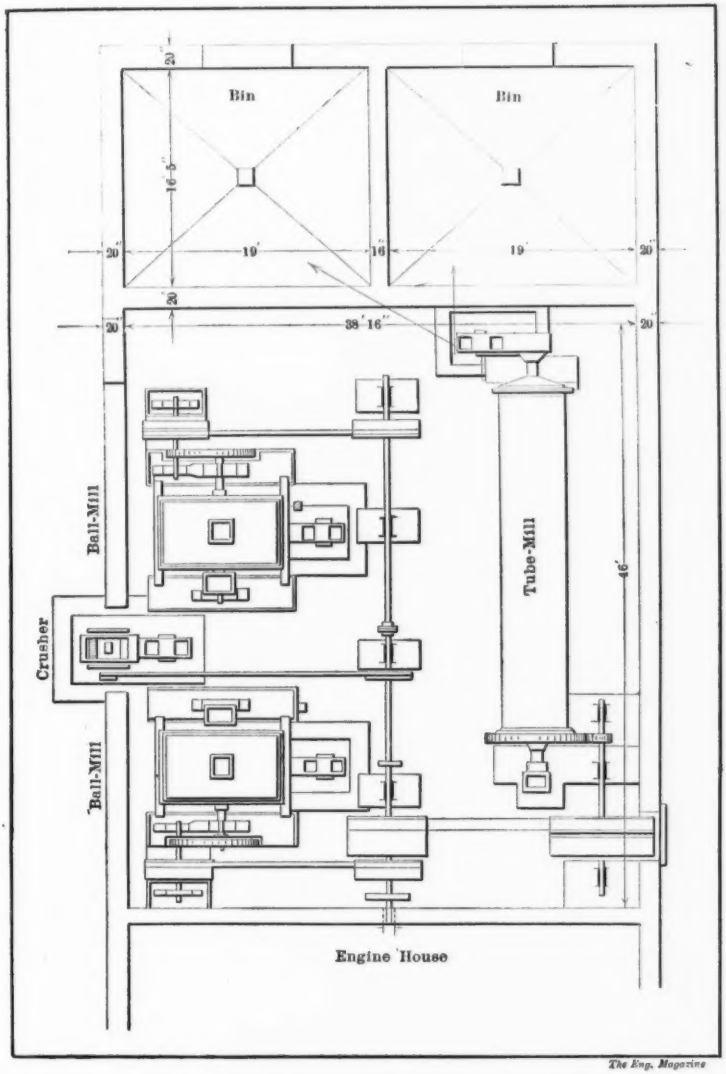


FIG. 6A. PLAN OF THE SEPARATOR ARRANGEMENT SHOWN ON THE OPPOSITE PAGE.

Two 9-ft. ball mills, one 5-ft. tube mill, two 7-ft. separators.

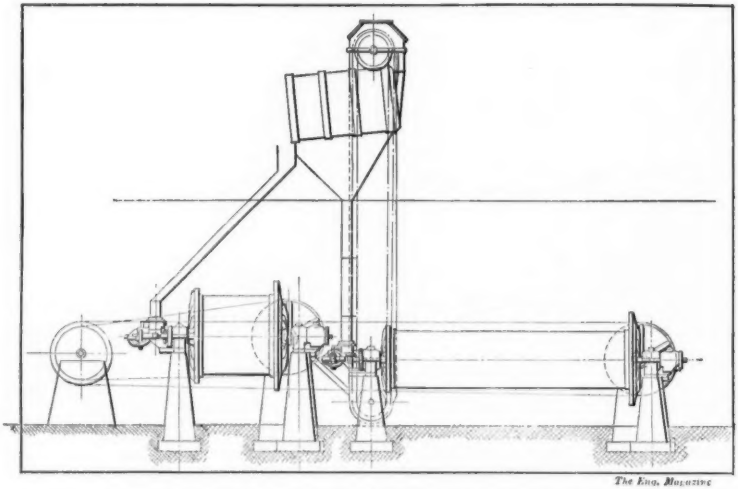


FIG. 7. ARRANGEMENT OF BALL AND TUBE MILLS AND SCREENS.
Designed by the Allis-Chalmers Co.

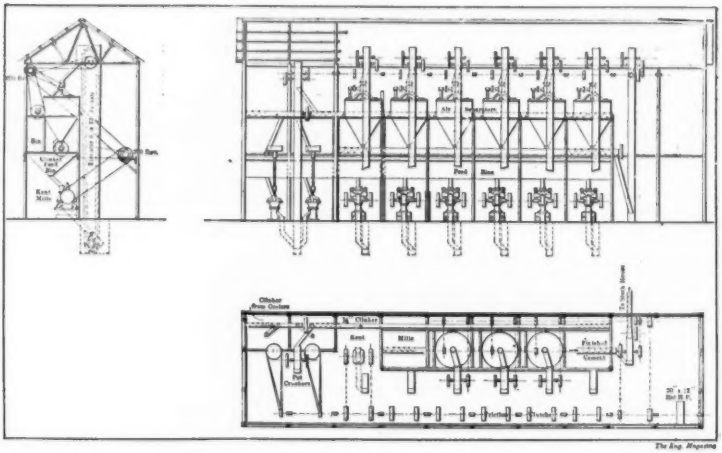
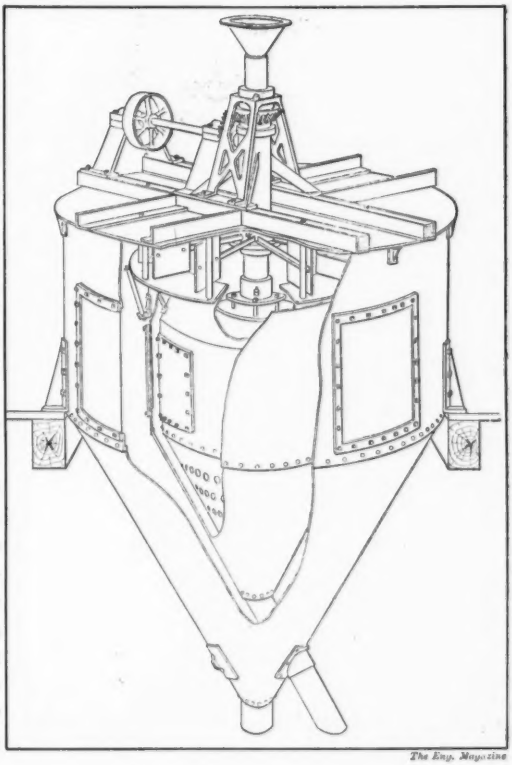


FIG. 8. A 1500-BARREL PORTLAND-CEMENT PLANT USING KENT MILLS.
Showing the arrangement of the mills in conjunction with bins and separators. Kent Mill Co., New York.

the fine material. In Figure 6 is shown a separator installed between ball and pebble mills. It receives the product of the ball mills, sepa-

rates the fines, and forwards them as finished product, and delivers the tailings to the pebble mill. In Figure 7 is shown a special ball mill sending its product to a revolving screen, or in other words, effecting its separation entirely outside the machine, returning the tailings and sending the fines to the pebble mills. This scheme as shown is advantageous only to the ball mill. If a separation of the fines could be effected before they go to the pebble mill further advantage would be gained.



The Eng. Magazine

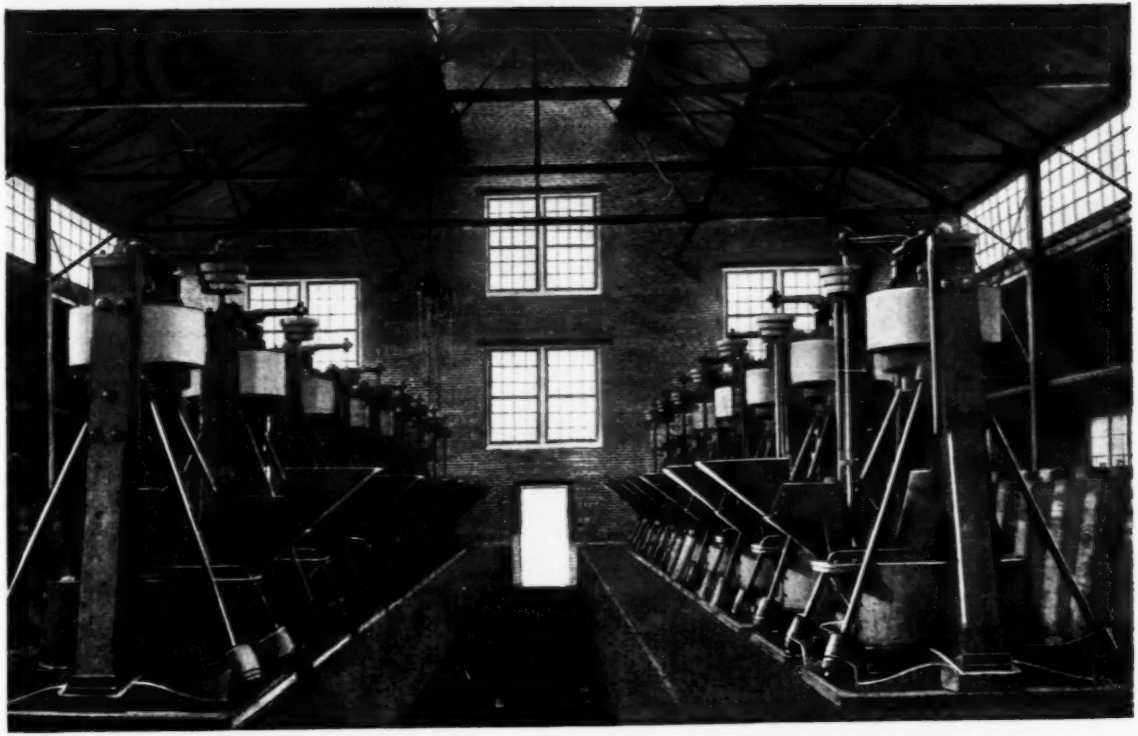
EMERICK'S AIR SEPARATOR.

Extracts the finished portion of the tube-mill product, returning the unfinished to be reground. George S. Emerick, Nazareth, Pa.

There are a number of mills of different types which can grind only by separation, which, in fact, yield no uniform product without separation. Of these the Kent mill may be taken as a type. In Figure 8 is illustrated a battery of Kent mills working in conjunction with bins and separators to produce finished cement.

It is not necessary nor is it practicable in this article to describe or illustrate the great variety of expedients which can be adopted for separation of one form or another. The various methods and treatments to suit different conditions and different grinding machines could be multiplied indefinitely.

In addition to the wind separator which has been so frequently mentioned above, there are, of course, numerous mechanical separa-



AN INSTALLATION OF GRIFFIN MILLS. PLANT OF THE UNITED STATES PORTLAND CEMENT CO., BEDFORD, IND. BUILT BY THE BRADLEY PULVERIZER CO., BOSTON, MASS.

Photograph by courtesy of the Osborn Engineering Co., Cleveland, O.

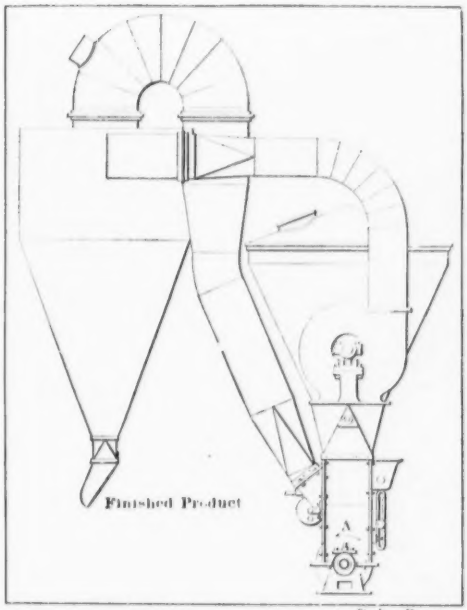


FIG. 10. RAYMOND AUTOMATIC PULVERIZER WITH VACUUM SEPARATOR.

tors effecting separation through screens by mechanical devices. Every flour mill is equipped with some sort of bolting machine for separating finished product. There are inclined screens, revolving screens, impact screens—indeed, a great variety to choose from for this purpose and for different conditions. In the text above the Askham and Pfeiffer separators have been referred to. Figure 9 represents a similar separator made in the United States by Emerick. In Figure 10 is illustrated a separator of this type, but with some elaboration, known as the Raymond separator.

Figure 11 illustrates a form of inclined shaking screen adapted for certain purposes, which is manufactured by the Newaygo Portland Co. In Figure 12 is illustrated in elevation and section another form of shaking or impact screen known as

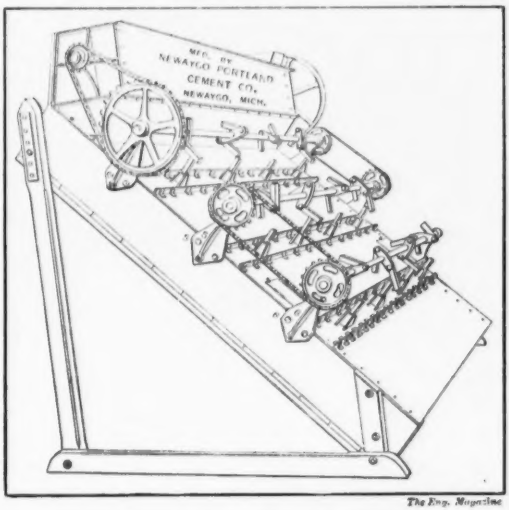


FIG. 11. THE NEWAYGO SEPARATOR.

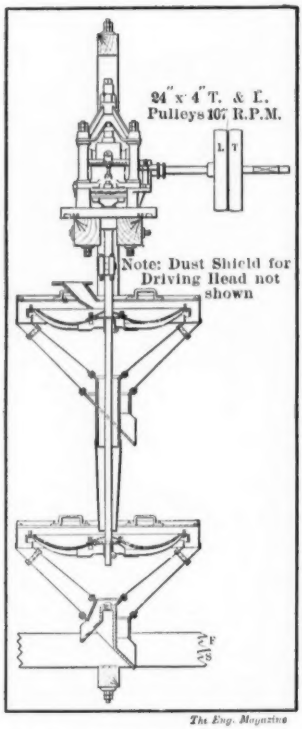


FIG. 12. DOUBLE-UNIT TRAYLOR CENTRIPACT SCREEN

the Centripact screen which has been used considerably in mining operations. There are various similar devices to be had too numerous to mention. The figures above mentioned illustrate the character of this kind of machinery.

It might appear from what has been said above to be a self-evident fact that separation must offer important advantages and economies. This is, however, not necessarily the case, as I have taken the trouble to suggest at several points in the discussion above. The wear and tear in grinding Portland cement is quite extraordinary. It is particularly heavy on elevating and conveying machinery, on screens, on bearing and wearing services of all kinds. This fact must never be lost sight of. If, therefore, a separating system is put in which requires increased size and height of buildings, which complicates the elevating and conveying machinery, then the wear and tear, the loss of output due to shutdowns of this machinery and of the separating devices, may introduce factors which not only fail to show advantageous results but may, in fact, be much more expensive than the simpler installation. The problem, therefore, is by no means a simple one. It requires a nice adjustment of means to ends and a careful study of conditions. At the present time it is doubtful if anyone will be justified in making extensive installation of this kind until the results are fully demonstrated experimentally on a smaller scale. Yet it is quite certain that results of a satisfactory character will be had.

THE PLANNING AND CONSTRUCTION OF THE POWER PLANT.

By A. E. Dixon.

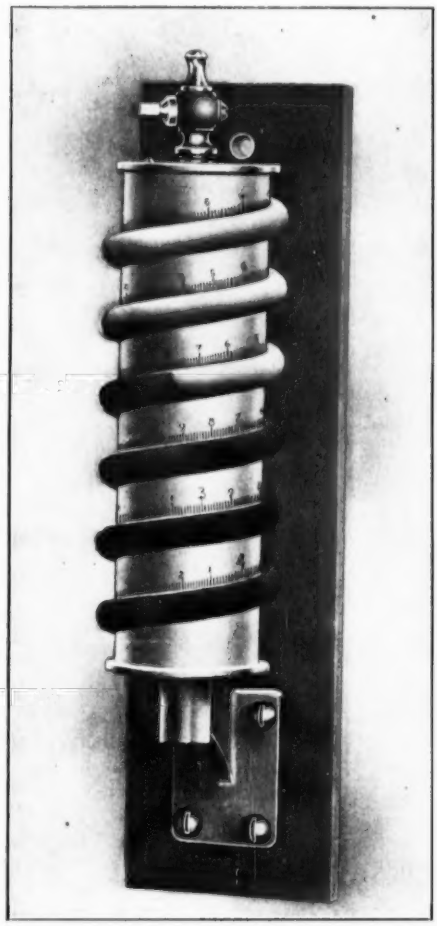
III. NATURAL AND MECHANICAL DRAFT.

Mr. Dixon's article in our September number discussed the location of the plant and the storage and handling of fuel. His second paper took up boilers, stokers, chimneys. His topic in December will be water supply and its purification, so far as concerns the power plant. —THE EDITORS.

THE operation of the steam power plant is dependent upon the combustion of fuel beneath the boilers, which in turn depends upon the intensity of the draft available. The intensity of draft required depends upon the quality of the fuel used and upon the quantity to be burnt on a square foot of grate in a unit of time. Insufficient draft, probably, produces more trouble in steam plants than any other single cause. A strong draft permits of forcing the boilers at times of overload and in this respect is equivalent to a certain amount of additional boiler heating surface; the successful use of cheap low-grade fuels likewise requires a strong draft.

Natural or chimney draft is due to the action of gravity upon two columns of gases of different densities; mechanical draft is produced by steam-jet blowers or fans, and may be either forced or induced.

As the operation of the chimney is dependent upon natural causes, its draft intensity is affected by atmospheric and barometric conditions, and while as long as the chimney stands a draft can be established, the only control possible consists in reducing the intensity by means of dampers. For these reasons a chimney must be designed with both sufficient area and height to carry off the waste gases and to supply the maximum draft required under the most unfavorable conditions. If the chimney is too small, an increased consumption of fuel will be required to heat the waste gases to a temperature at which the required draft intensity will be produced, and should unfavorable atmospheric conditions prevail, considerable difficulty will be experienced in keeping up the fires. Chimney draft can, of course, be supplemented by means of fans or blowers, and in some modern plants it has been deemed advisable to install fans and at the same time provide a high chimney. The steam-jet blower is the simplest and



THE SARGENT DRAFT GAGE.

For vacuum or pressure; direct-reading, 6-in. range, graduated to .01-in. The tube is celluloid; the liquid used is common water. Sargent Steam Meter Co., Chicago, Ill.

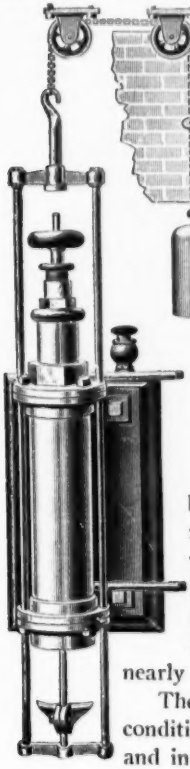
easiest to install, and it is frequently used in small plants. These devices are noisy, and at the best economy credited to them consume 8 per cent of the steam generated; they may use three or four times this quantity. If it is desired to introduce a small amount of steam below the grates in order to reduce the trouble with clinkers, it can be done in a more economical manner. Mechanical draft is at all times under complete control, and may be regulated to suit the load carried; but owing to the uncertainty of all things mechanical, such apparatus should be installed in duplicate; if suitable spare parts are carried in stock the precaution will usually be sufficient.

The following table shows the theoretical draft intensity of a stack 250 feet high, for two temperatures of the waste gases and different atmospheric and barometric conditions. The temperatures used are the maximum, minimum, and mean annual temperature at New York city. The barometric conditions are the normal, and the highest and lowest recorded in New York and occurred, respectively, on Feb. 5, 1887, and Nov. 13, 1904.

THEORETICAL DRAFT IN INCHES OF WATER. 250-FEET CHIMNEY.

Waste gases.	+455° F.			+608° F.		
Barometer ins.	29.92	28.70	30.94	29.92	28.70	30.94
Air. — 6° F. dry.	2.12	2.04	2.19	2.42	2.29	2.49
+52° F. dry	1.65	1.58	1.69	1.94	1.84	2.01
Saturated	1.63	1.56	1.68	1.92	1.82	1.99
+100° F. dry	1.32	1.27	1.36	1.62	1.53	1.67
Saturated	1.24	1.19	1.28	1.54	1.45	1.59

The actual draft intensity will be from 5 to 30 per cent less than the theoretical, the lower losses occurring where the chimneys are of large diameter and in the best condition, the higher losses taking place in old chimneys in poor condition and in stacks of small diameter. At the Manhattan Power house in New York, during a test made on Aug. 15, 1903, the draft reading at the base of the stack was 1.08 inches of water and the temperature of the waste gases was +295° F. During this test the following average atmospheric conditions prevailed: temperature of the air +74° F.; barometer, 30.10 inches; humidity, 60 per cent. The theoretical draft corresponding to these conditions is 1.15 inches of water, showing a loss in draft intensity of but 6 per cent, with a new chimney of large diameter in first-class condition. This result is a practical demonstration of what may be realized under nearly ideal conditions.



DAMPER REGULATOR.

The piston, fitted with water packing in a composition cylinder, is chain connected to the damper lever and works in opposition to the weight. The piston motion is controlled by a metallic diaphragm, which may be set for any desired pressure by the screw handle and is then said to be sensitive to a change of ¼ lb. in the boiler pressure. Julian d'Esté Co., Boston, Mass.

The intensity of the draft produced by a chimney, other conditions being the same, is dependent upon its height, and in 1884 the *Locomotive* published a table giving the

TABLE OF DIMENSIONS OF SOME IMPORTANT CHIMNEYS.

	Rapid Transit N. Y.	Port Morris N. Y.	Manhattan N. Y.	Long Island City	Chelsea London England
Diameter in feet	15	15.5	17	16	19
Height in feet above lower grate	225	250	267	250	255
above upper grate			234	225	222
of shaft in feet	162	212	278	275	275
Area at top, sq. ft.	176	188	227	201	283
Make or material	Custodis	Custodis	Custodis	Steel	Brick
Lined	Base	Base	Base	to top	?
Boilers, make	B .& W.	B. & W.	B. & W.	B. & W.	B. & W
Number per stack	12	12	16	16	20
Heating surf. sq. ft. each	6,000	6,250	5,200	5,243	5,212
Superheating surf. sq. ft. each	—	1,230	—	1,116	672
Grate, sq. ft. per boiler	100	112	110	100	83
Stoker or hand	Hand fired	Roney stoker	Roney stoker	Roney stoker	Chain grate
Forced draft,					
Blowers per stack	4	None	4	None	None
Cu ft. free air per minute	—	—	57,000	—	—
Ash-pit pressure in. of water	—	—	1.7	—	—
Steam pressure, lb. per sq. in.	175	185	150	195	—
Superheat °F.	—	200	—	200	—
Economizers,	yes	none		yes	
heating surf. sq. ft. per boiler	—	—	1,536	—	1,540
Stack Area					
Grate Area	0.147	0.14	0.129	0.126	0.171
Sq. ft. stack area per 1,000 sq. ft. heating surface	2.44	2.51	2.73	2.40	2.71

" height of water column due to unbalanced pressure in a chimney 100-feet high " for various temperatures of air and of the waste gases at a barometric pressure of 14.7 pounds per square inch; therefore it is a matter of simple proportion to apply this table to a chimney of any height, the barometric correction for cases in which the chimney is located above the sea level can be also be made by proportion. The table mentioned has been very widely copied; it can be found in Kent's " Pocket Book " and in a number of other works. In using this lathe for the purposes of designing it is advisable to refer to the columns for air temperatures of + 90° and + 100° F. and allow at least 10 per cent for friction and other losses.

The area of the chimney is determined by the volume of waste gases to be passed, and this depends upon the temperature of the gases and is also affected by the kind of coal used; this latter element is not

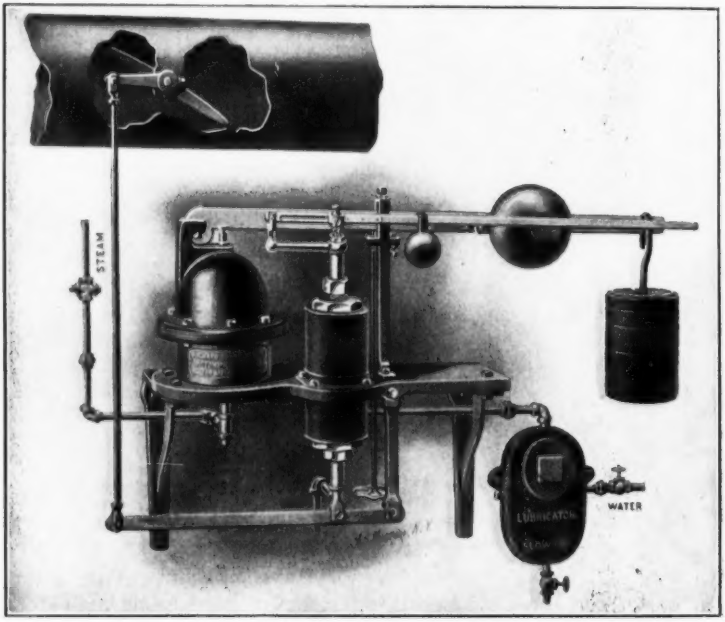
DIMENSIONS OF IMPORTANT MODERN CHIMNEYS; CONTINUED.

Waterside New N. Y.	Edison Boston Mass.	North Beach Cal.	Fisk St. Chicago Ill.	Kingsbridge N. Y.	Philadelphia, Delaware Ave.	R. T. Vernon St.
20	18	14.67	18	14	14	11.25
300	230	149	200	200	225	170
264						
232	250	152	175	—	200	—
314	254	168	254	154	154	99
Steel to top B. & W.	Custodis — B. & W.	Custodis 77ft B. & W.	Steel to top B. & W.	Steel to top B. & W.	Steel to top Parker	Steel to top B. & W.
24	16	16	16	15	8	10
6,500	5,118	5,242	5,000	5,200	8,000	3,750
1,000	867	—	—	—	—	—
126	110	—	—	84	160	68
Hand fired	Roney stoker	Oil burners Induced	Chain grate	Roney stoker Induced	Roney stoker	Hand fired
8	None	2	—	2	None	Steam jet
90,000	—	—	—	—	—	—
2 X 175	—	—	—	3	—	—
100	175 150	200 —	180 150	160 —	175 100	145 —
None	None	2,124	None	1,020	None	None
—	—	—	—	—	—	—
0.104	0.144	—	—	0.122	0.12	0.146
2.01	3.11	2.01	3.18	1.97	2.41	2.64

considered in the usual chimney formulas, though the volume of waste gases from one kind of coal may exceed that from another coal by 50 per cent. An old rule-of-thumb was to make the chimney one-eighth of the area of the connected grate surface; the appended table of chimney dimensions, from some recent plants, shows that this ratio is exceeded in most cases. There are a number of chimney formulas in existence and serious efforts have been made to develop a rational formula to replace the various empirical formulas, this last being somewhat difficult owing to the fact that there are a large number of variables in the equation. Kent's empirical formula gives satisfactory results, but it is not necessary to increase the size of the chimney to allow for friction losses, except with areas of less than 80 to 100 square feet. The formula is as follows:—

$$\text{Area of chimney in sq. ft} = \frac{0.06 \times \text{pounds of coal burned per hour}}{\sqrt{\text{height of chimney in feet}}}$$

Mechanical draft has made much greater headway in marine work than it has on land, for the reason that in the former service the increase in steaming capacity per ton of boiler so gained was of high importance. On land a decrease in the dead weight of the boilers is not so important, but a reduction in the cost of the plant may result. Some of the large plants recently completed are supplied with fans in order to guard against any possible deficiency in the chimney draft. With natural draft it is rarely practicable to burn more than 40 pounds

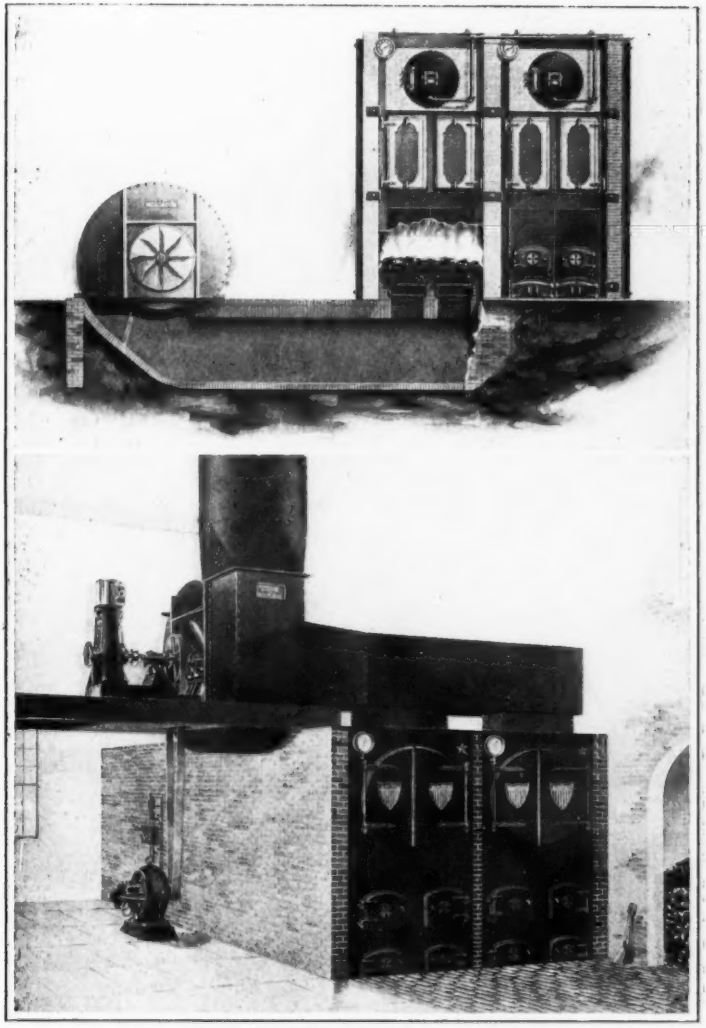


THOMPSON AUTOMATIC DAMPER AND PRESSURE REGULATOR.

Opens and closes the dampers by water pressure, with positive power in both directions, sensitive to variation in the steam pressure. Richard Thompson & Co., N. Y.

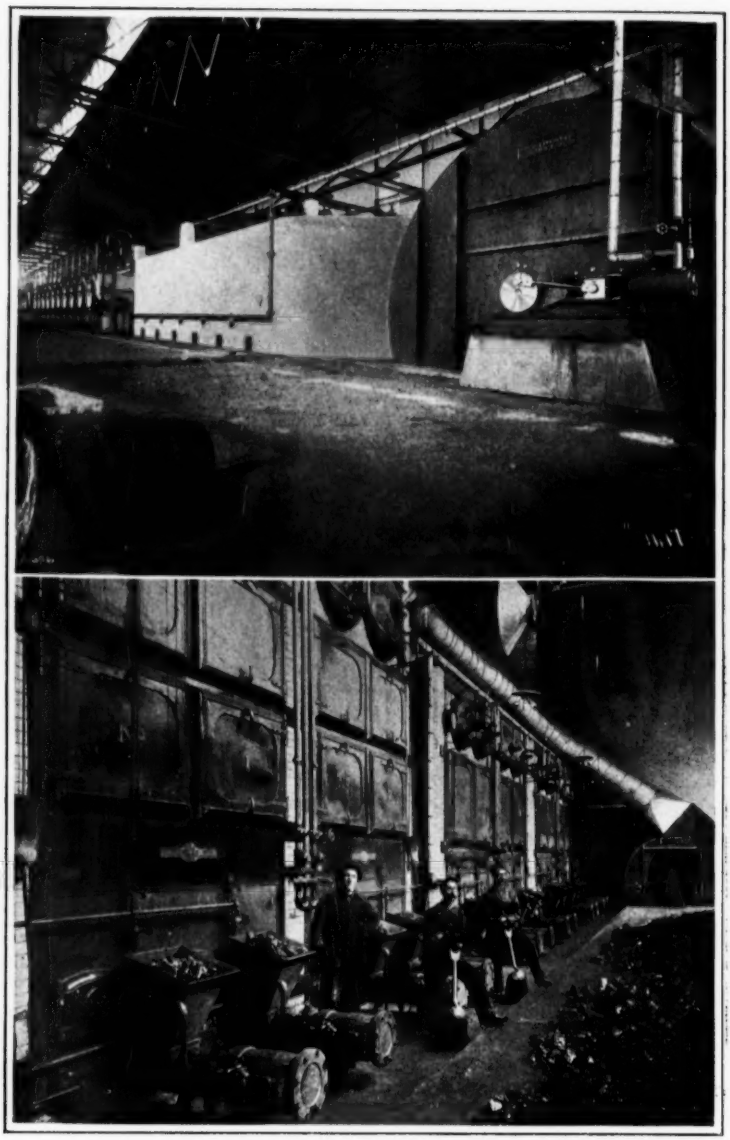
of coal per square foot of grate, while with forced or induced draft the amount of coal burned may be as high as desired; 125 pounds per square foot has been burned on locomotives and torpedo boats, and this rate could be doubled if desired.

The advantages of mechanical draft are that while except in isolated instances the chimney cannot be dispensed with, it may be reduced somewhat in size; the boiler plant can be reduced to its



CHARACTERISTIC EXAMPLE OF MECHANICAL-DRAFT INSTALLATIONS.

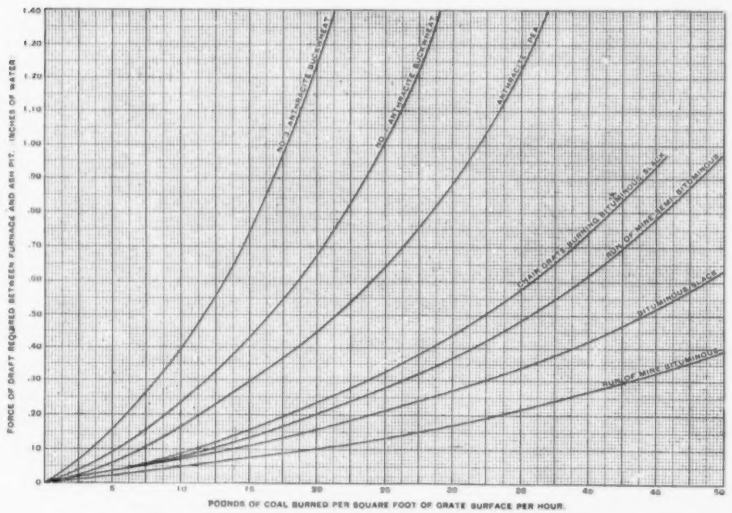
The upper one is the forced-draft arrangement at the North Western colliery of the Temple Iron Co., Carbondale, Pa.—a 120-in. three-quarter housed fan driven by 8 by 8 vertical engine, direct-connected. The lower is an induced-draft plant for the Locke Insulator Co., Victor, N. Y., using a fan of the same size driven by a 6 by 6 engine with motor auxiliary. Both by the American Blower Co., Detroit, Mich.



CHARACTERISTIC EXAMPLES OF MECHANICAL DRAFT INSTALLATIONS.

Above, induced-draft apparatus and economizer, power plant of the Wood Worsted Mills, Lawrence, Mass. Below, forced-draft-appliances with stokers at Portland Street Railway Co's. power house, Portland, Me. Both by the B. F. Sturtevant Co., Hyde Park, Mass.

lowest terms; the draft is entirely within control and can be regulated to suit plant requirements; low-grade fuel can be used. The disadvantages lie in the addition to the mechanical equipment which must be maintained; and the expenses of operation of the apparatus. In deciding as to the advisability of such installations, each case must be decided upon its own merits according to local conditions. Where it is necessary to build tall chimneys, in order to prevent the waste gases becoming a nuisance to the neighborhood, chimney draft may be a cheap by-product; and while it may be the part of wisdom to add fans to guard against the worst possible combination of circumstances, such fans may never be put in operation, unless the occasion should arise that the plant was forced to use a fine anthracite coal.

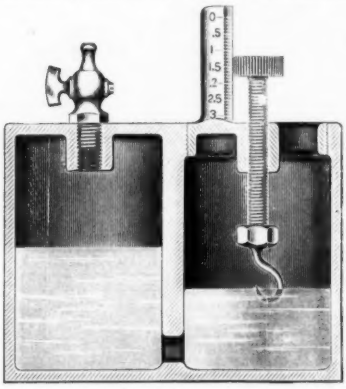


CURVES SHOWING DRAFT REQUIRED BETWEEN FURNACE AND ASHPIT AT DIFFERENT COMBUSTION RATES, FOR VARIOUS KINDS OF COAL.

By courtesy of the Stirling Consolidated Boiler Co.

Induced draft is a close imitation of the natural, and like it is affected by the infiltration of air through the brick work; but unlike chimney draft this does not reduce the draft intensity, though there will be loss of heat from this cause. Forced draft, on the contrary, produces a plenum instead of a vacuum in the boiler setting and flues, the leakage being outward, and this principle has been found the most satisfactory in the operation of metallurgical furnaces and for mine ventilation. With this system cool air is handled by the fans instead

of the hot products of combustion. Forced draft may be either the closed fire-room system, as is extensively used in the Navy (where it is almost impossible to secure adequate ventilation of the stokehold by other means), or the closed ash-pit system, which is the most desirable system and the most practicable for plants located on land. With properly designed boilers no trouble should arise from leaky tubes even with air pressures as high as 8 to 10 inches of water; this is particularly the case when mechanical stokers are used.



HOOK DRAFT GAUGE, WITH MICROMETER.

From a "Treatise on Mechanical Draft," by courtesy of the B. F. Sturtevant Co.

The drop in draft intensity in a water-tube boiler will vary from 0.20 to 0.40 inches of water, and may exceed the higher figure should the boiler be forced to a high evaporation. The pressure required to force the air required for combustion through the grates and the bed of coal varies within very wide limits, being affected by the kind and quality of the fuel, the methods of firing, and the rate of combustion. The following table gives the approximate draft intensity required for economical combustion under average conditions.

DRAFT IN INCHES OF WATER IN THE FIRE-BOX FOR VARIOUS RATES OF COMBUSTION.

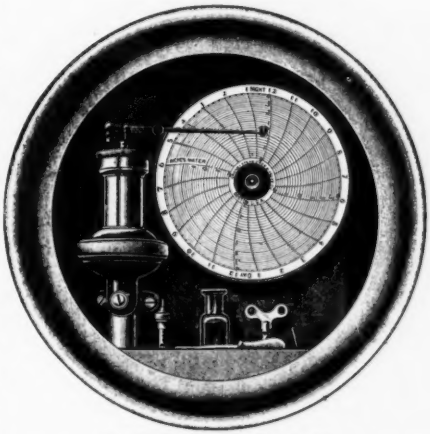
Fuel used,	Pounds of coal burned per square foot of grate per hour.				
	20	28	32	36	40
Bituminous (hand)	.20	.40	.50	.60	.80
" (stoker)	.30	.50	.60	.80	1.00
Anthracite, pea	.50	.90	1.20		

DRAFT IN INCHES OF WATER AT BOILER WALL FOR VARIOUS RATES OF COMBUSTION.

Fuel used,	Pounds of coal burned per square foot of grate per hour.				
	20	28	32	36	40
Bituminous (hand)	.40	.60	.75	.90	1.20
" (stoker)	.50	.70	.85	1.15	1.40
Anthracite, pea	.70	1.10	1.45		

A certain part of the draft is lost in the smoke flues through friction. These flues should have an area from 10 to 20 per cent in excess of that of the chimney, or from 3 to 4 square feet per 1,000 square feet of connected heating surface for large flues, and from 4 to 5

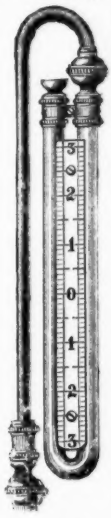
square feet in the case of small flues. A common allowance for the friction loss is 0.10 inch of water per 100 feet of flue and 0.05 inch of water for each elbow, for circular flues; when square flues are used these values are doubled.



CROSBY DRAFT RECORDER.

For automatic and continuous registration. Crosby Steam Gauge & Valve Co., Boston.

Economizers introduce considerable friction in the flue system in addition to the loss of draft caused by the heat abstracted from the waste gases, the drop varying from 0.20 to 1.00 inch of water, according to the length of the economizer, its area and the number of elbows it causes in the gas passage. The straight-passage economizers cause less friction than those with staggered tubes, but the staggered tubes should be more efficient as heat absorbers.

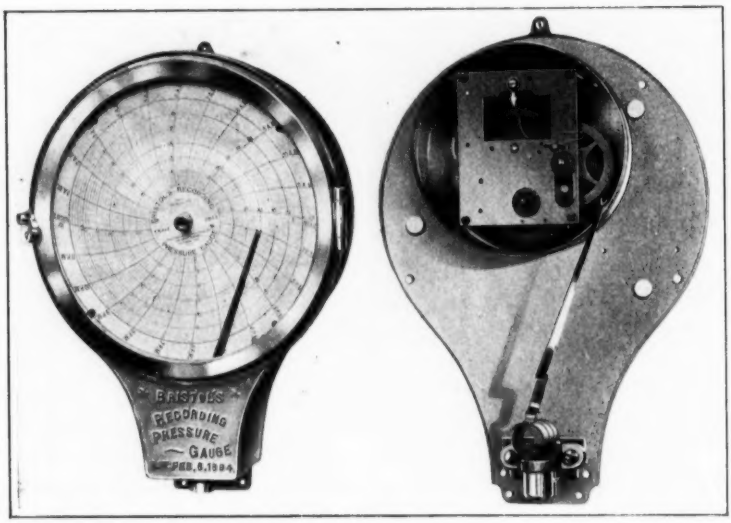


WATER GAUGE FOR LOW PRESSURES.*

For economical operation the heat of the waste gases should be low—under normal conditions, not over +300° F.—and they should not exceed +600° F. with 50-per-cent overload.

Power-plant managers are commencing to wake up to the fact that the boiler room offers far greater opportunities to reduce operating expenses than can be found in any other portion of the plant. It has been the habit to regard the engine room as the show portion of the plant, and the boiler room and the "black gang" have apparently been looked upon as necessary evils to be kept in the background. Cheap labor, scanty supervision, poor methods and dirty surroundings characterize the picture of many boiler rooms, though there are some exceptions. In the ordinary boiler room the steam gauge, and in some cases a high and low-water alarm, are the only apparatus by which the fireman can judge his work, and the intro-

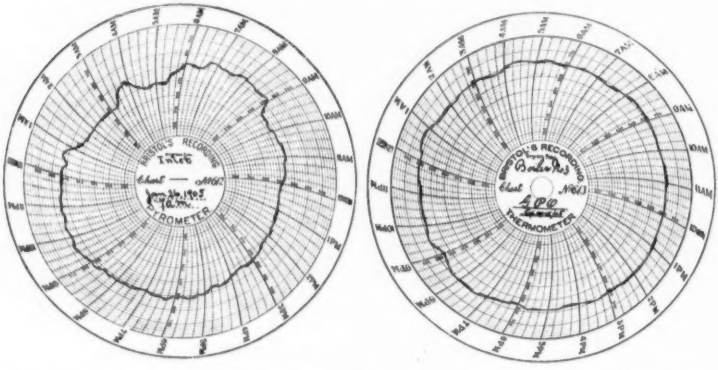
* From "Treatise on Mechanical Draft," by courtesy of the B. F. Sturtevant Co.



BRISTOL'S RECORDING PRESSURE GAUGE, EXTERNAL AND INTERNAL VIEW

The form shown is applicable to pressures or vacua exceeding 4 lb. For lighter pressures, (within the 4 lb. limit either way from zero) the spiral tube is replaced by a different sensitive device. The Bristol Co., Waterbury, Conn.

duction of a recording steam gauge, upon which the fireman must keep an even steam line or get "jacked up," is considered the height of refinement. The incentives to fuel economy, in the United States



FAC SIMILE OF CHARTS, BRISTOL RECORDING PYROMETER AND THERMOMETER.

The clockwork can be supplied to give any desired period of revolution.

in particular, have been small, owing to the comparatively low cost of good steam coal; but a close study of the laws and conditions governing combustion will be amply repaid, even in plants of moderate size, while in large plants a saving of a very few per cent of the fuel bill will warrant the installation of quite a laboratory.

The losses occurring in the combustion of fuel can be summarized as follows:—

1—Loss due to incomplete combustion.

2—Sensible heat carried off in the waste gases.

3—Radiation and convection losses.

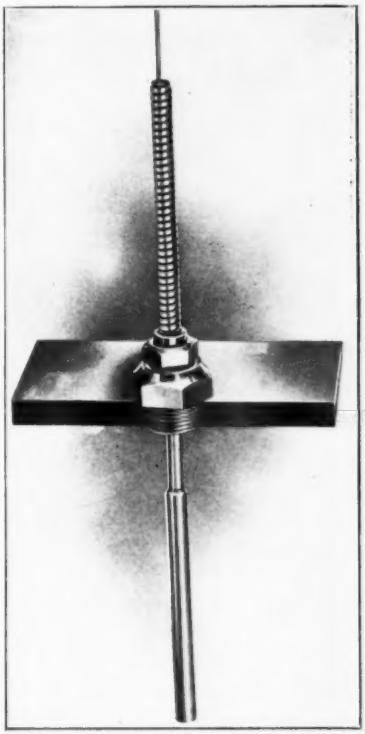
4—Heat lost in the evaporation of moisture contained in the fuel.

5—Latent heat in the waste gases of the superheated steam formed from the moisture in the fuel and the combustion of the hydrogen.

6—Loss in heating the excess air supply to the temperature of the waste gases.

7—Loss of heat due to the infiltration of air.

8—Loss in the ashes, due to unburned combustible and the sensible heat of the ashes.



BRISTOL RECORDING THERMOMETER.

The liquid in the bulb, expanding under heat, transmits the expansion pressure through a capillary tube to a recording instrument exactly similar to the pressure gauges shown on page 238. The recording disk may therefore be quite removed from the place of temperature observation.

Apparatus is available by which continuous records can be secured of the percentage of carbon dioxide (CO_2), the temperature of the waste gases, and of the draft; and its use will lead to a considerable reduction in the losses items 1, 2, 5, 6 and 7; item 3 is difficult to determine, except by assigning to it a value obtained by deducting the sum of the percentage values of all the other losses from

BROWN'S RECORDING PYROMETER.

Edward Brown & Sons, Phila., Pa.

100, or a radiometer can be used, which would be a delicate and troublesome piece of work; item 4 cannot be entirely avoided and is comparatively small; item 8 with good practice should not exceed 2 to 3 per cent, and it is doubtful whether the labor and care required to reduce this loss would be offset by the resulting saving.

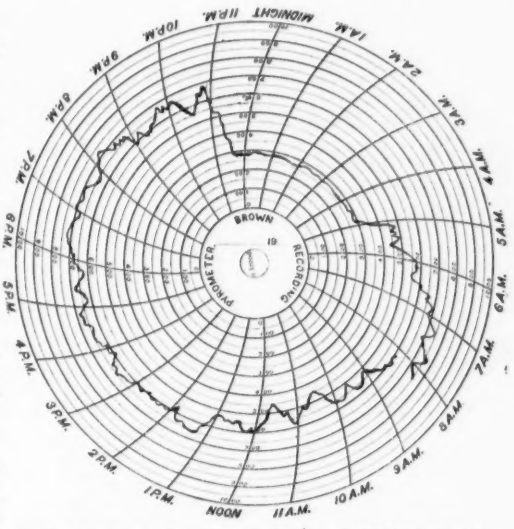
The diagrams obtained from the pyrometer and the CO_2 apparatus make a very close check on each other and at the same time furnish an accurate log of the boiler to which they are connected. In certain types of CO_2 apparatus the diagram is made from a continuously aspirated sample of the flue gases, which is more accurate inherently than those operating on samples taken at intervals.

In my opinion the pyrometer should have a double recorder, so that continuous records at two points can be secured simultaneously; in a boiler setting, at the bridge wall and the boiler outlet, or at both ends of the smoke flue, or at the economizer inlet and outlet. The CO_2 apparatus should record the percentage of this gas at the boiler outlet. The apparatus should be connected with each boiler in turn and a complete record should be made for either one shift or one day, with the recorder hidden in order to get a base record on each man. After this has been done the recorder should be exposed and its purpose and use fully explained to the men. A continuous record of the draft intensity of each boiler and of the steam pressure carried will prove a valuable adjunct to the study and comparison of results. It is also desirable that the weight of the fuel used and the resulting ash should be recorded.

In addition to the above apparatus it is desirable that the plant should be equipped with apparatus by which continuous records may be obtained of the barometric pressure, temperature, and humidity of

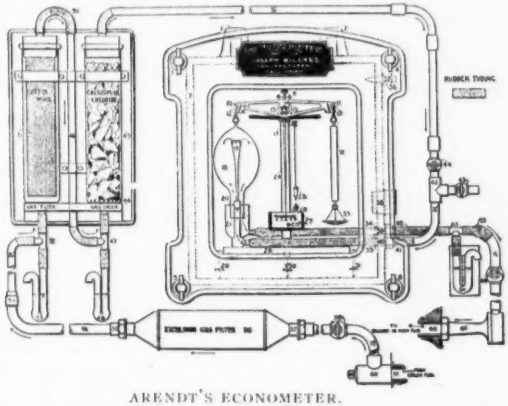
the air, together with an accurate mercurial barometer, wet and dry-bulb, and maximum and minimum thermometers.

In using the continuous CO_2 apparatus it is advisable to check it from time to time by an analysis of the waste gases. The Orsat apparatus is convenient for use in power plants for this purpose, and if carefully used is accurate and reliable. It takes from 25 to 30 minutes with this apparatus to make a determination of the volumetric percentage of carbon dioxide (CO_2), oxygen (O), and carbon monoxide (CO); these gases are absorbed in the pipettes, the volume remaining being nitrogen (N). With bituminous coals there is the possibility of a certain percentage of the volatile hydrocarbons escaping unburnt; this can only be de-



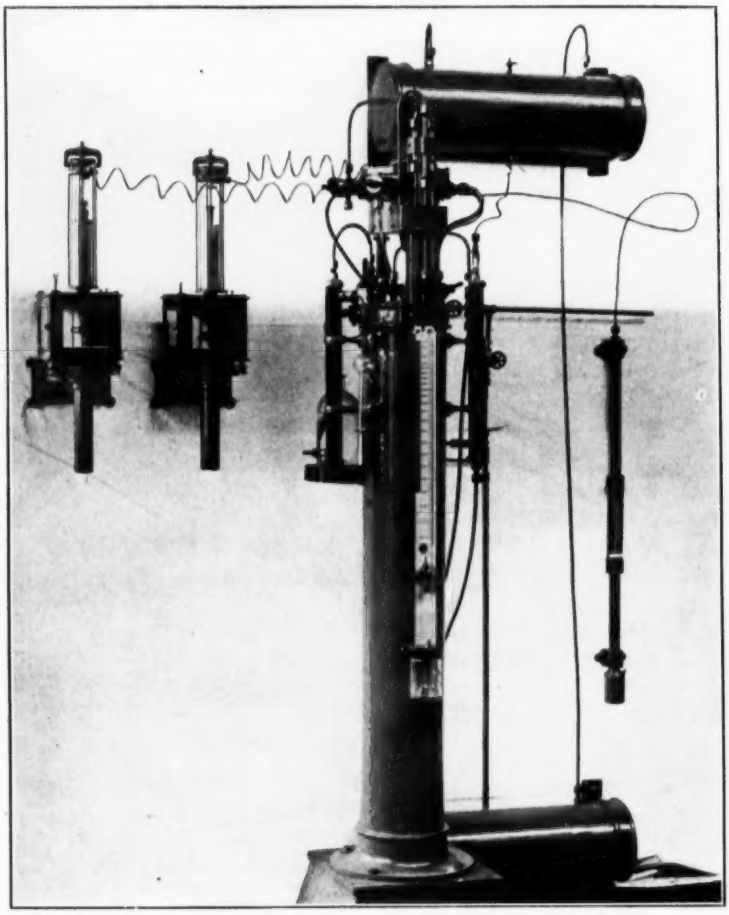
FAC SIMILE OF CHART, BROWN'S RECORDING PYROMETER.

Reduced from the original, which is 6 in. in diameter. The record is of one day's run in a six days' boiler test made by D. Ashworth & Son. Edward Brown & Son, Phila., Pa.



ARENDT'S ECONOMETER.

A continuous and automatic apparatus, serving without skilled labor to indicate the percentage of CO_2 in the combustion gases. The J. Wilckes Co., N. Y.



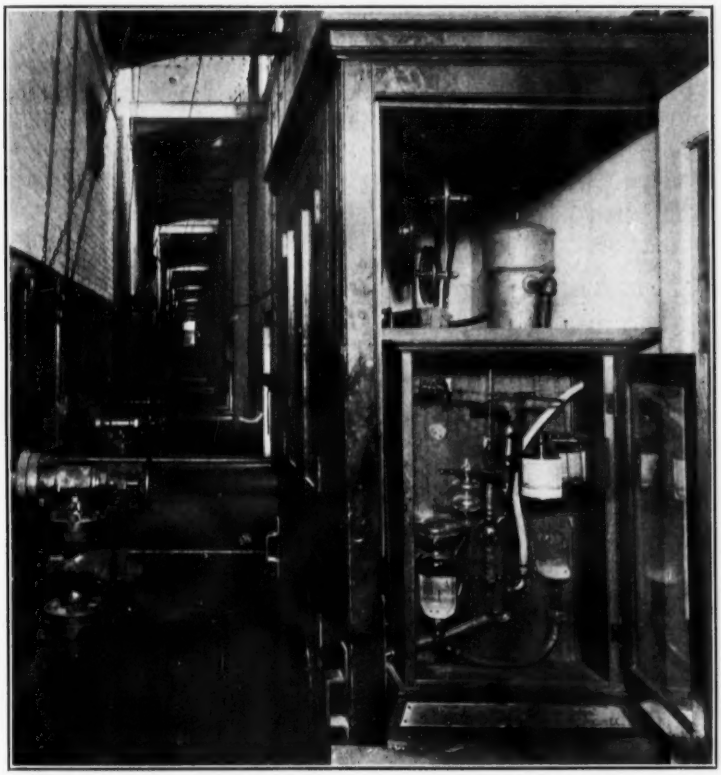
THE UEHLING COMBINED GAS COMPOSIMETER AND PYROMETER.

Furnishes a continuous autographic record of the percentage of CO_2 in a gas mixture. Uehling Decker Co., Passaic, N. J.

tected by the more complete analysis by the use of the Hempel apparatus, as with the Orsat apparatus these hydrocarbons are included with the nitrogen. In using the Orsat apparatus, as well as continuous CO_2 apparatus in which potassium hydroxide (caustic potash) solution is used, it is not desirable to work the solutions too close to their absorption capacity, because their action becomes slower and

slower as they become saturated, and accurate results are not likely to be obtained.

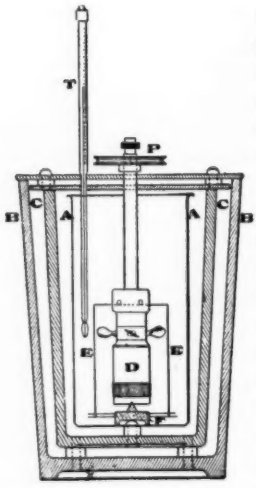
Smoke is often regarded as a sign of wasted energy, the amount of the waste being judged by the density of the smoke; to a degree this is true, smoke being the sign of incomplete combustion, but the heat value of smoke is very small. The best economy can be secured



"ADOS" CO_2 RECORDER. 59TH ST. POWER PLANT OF THE INTERBOROUGH CO. N. Y.

An apparatus for continuous and recorded analysis of the gases of combustion.
John A. Caldwell, N. Y.

only when complete combustion occurs in the fire-box, with but a slight excess air supply, and the chemical combination must be complete before the gases come in contact with the comparatively cold surfaces of the boiler. Anthracite coal is very nearly a pure fixed carbon, like coke or charcoal, and when sufficiently heated will burn to CO or CO_2 without smoke. Bituminous and semi-bituminous coals



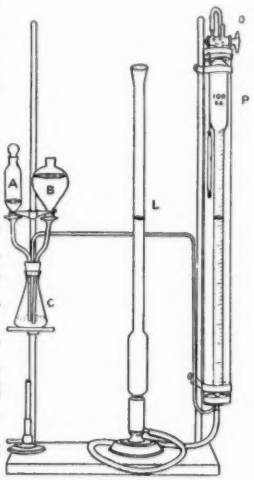
SECTION OF PARR STANDARD CALORIMETER.

The vessel A is filled with a definite volume of water. A weighed amount of the fuel, mixed with certain chemicals, is fired in the cartridge D. The resultant heat is absorbed by the water and measured by the thermometer T. Standard Calorimeter Co., East Moline, Ill.

carry besides the fixed carbons a considerable percentage of volatile combustibles or hydrocarbons, and the smoke-producing capacity of a fuel is proportional, roughly speaking, to its percentage of volatile matter. When these coals are placed upon a fire the hydrocarbons must first be distilled, and unless sufficient heat is present to ignite these gases and permit of their complete combustion, smoke will result. In many cases the trouble arises from the heat being sufficient to permit of partial combustion only; this will be shown by a flame of a smoky red or yellow tinge or of an opaque white. A brilliant transparent white or a clear red flame shows the absence of smoke. Smoke consists usually of a cloud of more or less fully condensed steam carrying flocculent carbon or soot in suspension.

The accompanying table of ignition temperatures (top of page 245) presents some interesting data in regard to the combustion of the volatile constituents of coal.

Another fallacy which nevertheless is firmly believed by many firemen is that there is great advantage in the use of damp or wet coal. There are situations and conditions, of course, as in the gas producer, under which the reaction between water vapor and incandescent carbon is highly desirable, and an essential part of the operation. These circumstances, however, are not found on the top of the fires in a boiler furnace. In some boiler rooms it is the practice to wet the coal down thoroughly before firing; this is of great assistance in the production of smoke and poor results, the temperature of the furnace being reduced by the heat required to evaporate the water and superheat it to the temperature of the waste gases.



PROF. PARR'S TOTAL CARBON APPARATUS.

After combustion in the calorimeter, the carbon of the fuel is converted into carbonate of soda. It is then liberated as carbonic acid, and measured in this apparatus.

TABLE OF TEMPERATURE OF IGNITION IN DEGREES FAHRENHEIT, UNDER ATMOSPHERIC PRESSURE 29.92 IN. OR 760 MM.

	1.	2.	3.	4.	5.	6.	7.
Hydrogen combining with oxygen $H_2 + O = H_2O$	—	—	1,130	1,031	1,071	—	—
Methane or marsh gas combining with oxygen $CH_4 + 4O = CO_2 + 2(H_2O)$	—	—	1,313	1,202	1,436	1,236	1,200
Ethylene or olefiant gas combining with oxygen $C_2H_4 + 6O = 2(CO_2) + 2(H_2O)$	—	—	—	—	1,022	—	—
Sulphur combining with oxygen $2S + 4O = 2(SO_2)$ forming sulphurous acid	—	—	—	—	—	—	—
$CO + O = CO_2$	—	—	—	1,211	1,202	—	1,211
In the presence of a large amount of CO_2 the combination $CO + O = CO_2$ occurs at a temperature of	—	—	—	—	1,292	—	—
Cannel coal ignities at	668						
Bituminous coal at	766						
Semi-bituminous coal at	870						
Anthracite coal at	—	925					

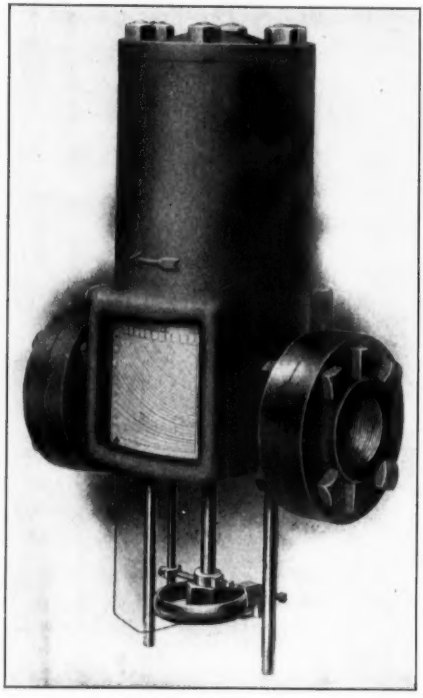
1. Vivian Lewes. 2. W. S. Hutton. 3. Victor Meyer.
4. Maillard and le Chatelier. 5. French Commission.
6. Mayer and Munich. 7. C. E. Stromeyer.

The following table shows approximately the percentage of volatile matter and of fixed carbon contained in the different kinds of coals; there is not however any hard and fast line between them, but each kind gradually fades off into the other, overlapping in places.

ULTIMATE ANALYSES OF THE PRINCIPAL COMBUSTIBLES.

	Percentage of					
	Moisture.	Vol. mat.	Car. Fixed.	Ash	Sulphur.	Phosphorus.
Cellulose	—	55.36	41.44	3.00	0.20	—
Peat	24.20	27.00	45.30	3.30	0.20	—
Lignite	—	27.90	66.09	4.00	1.00	—
Brown coal	—	29.06	66.31	2.27	2.36	—
Cannel	2.10	14.99	68.13	12.30	2.48	—
Albertite	—	57.70	41.00	0.40	trace	—
Bituminous	1.78	35.36	58.29	3.89	0.68	trace.
Semi-bituminous	1.20	23.89	67.56	6.69	0.66	0.055
Semi-anthracite	2.27	8.83	78.83	9.39	0.68	—
Anthracite	2.98	3.38	87.13	5.86	0.65	—
Graphite	—	—	99.00	1.00	—	—

The precise composition of the various fuels of the United States is being determined by the comprehensive tests of the United States Geological Survey, and if the name and locality of the coal under consideration be known its actual proportion of volatile matter and fixed carbon may be found in the report of the coal-testing plant.



SARGENT STEAM METER.

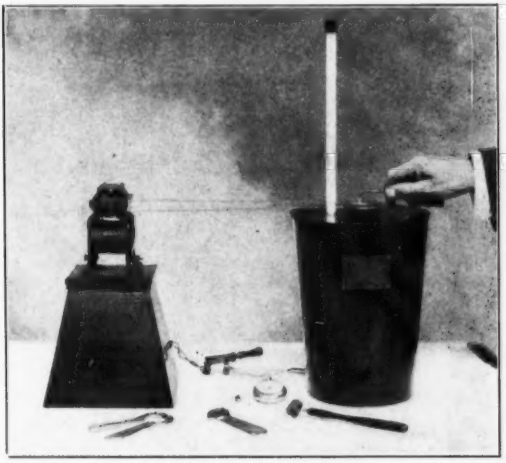
Records the pounds of steam passing through, irrespective of pressure. Sargent Steam Meter Co., Chicago.

In addition the bituminous or semi-bituminous coal may be caking or non-caking. Caking coal in burning fuses and swells, becoming first a pasty mass, and finally coking and burning; such coal causes a little trouble on mechanical stokers as the mass has to be broken up from time to time. Non-caking coal is sometimes called free-burning coal; it is easy to handle in the fire. The caking or non-caking properties of a coal cannot be determined by analysis, an experiment with the coal being the only method available.

In determining the heating value of fuel a very rapid and accurate method is the use of the Mahler calorimeter, but it can also be computed from the elementary analysis of the fuel by the use of Dulong's formula.

Some care is required in order to insure that the test sample of the coal represents a true average of the entire shipment it is taken from, and in metallurgical work this question of accurate sampling has resulted in the development of machines for the purpose of sampling and reducing the sample to convenient laboratory proportions. These generally proceed by progressive quartering and crushing, or screening through interrupted grids or troughs which intercept a certain fraction. In power plants the sampling can probably be best done at the weighing hopper by some automatic device, the large sample being later reduced by well-known methods to laboratory proportions. The original sample should be preserved for some time in order to

provide for check determinations in cases of dispute. The one-quart jars used in the household for preserving fruits furnish a convenient sized and cheap receptacle which can be hermetically sealed. Proper labels should be used for recording the data of the sample; a much better method is to give each sample a number only and record the data concerning it in a card index or a suitable loose-leaf book, as by this method the chemist does not have access to the data when a check determination is to be made.



THE PARR CALORIMETER.
External view, showing method of ignition by a hot wire.

TABLE SHOWING RATIO OF AIR SUPPLIED TO THAT THEORETICALLY REQUIRED FOR VARIOUS ANALYSES OF FLUE GASES.

$$\text{RATIO} = \frac{N}{N - 1.782\,O}$$

CO_2+CO	$N=79$ $CO_2+CO+O=21$	$N=79.5$ $CO_2+CO+O=20.5$	$N=80$ $CO_2+CO+O=20$	$N=80.5$ $CO_2+CO+O=19.5$	$N=81$ $CO_2+CO+O=19$	$N=81.5$ $CO_2+CO+O=18.5$	$N=82$ $CO_2+CO+O=18$
21	1.00	....	....	....	....	....	....
20	1.05	1.02	1.00	....	....	....	....
19	1.11	1.08	1.05	1.02	1.00	....	....
18	1.17	1.14	1.10	1.08	1.05	1.02	1.00
17	1.24	1.20	1.17	1.13	1.10	1.07	1.05
16	1.32	1.27	1.23	1.20	1.16	1.13	1.10
15	1.40	1.35	1.31	1.27	1.23	1.19	1.16
14	1.51	1.45	1.39	1.35	1.30	1.26	1.23
13	1.62	1.55	1.50	1.44	1.39	1.34	1.30
12	1.76	1.68	1.61	1.54	1.49	1.43	1.38
11	1.92	1.82	1.74	1.66	1.60	1.53	1.48
10	2.11	2.00	1.90	1.81	1.72	1.65	1.59
9	2.35	2.21	2.08	1.97	1.88	1.79	1.71
8	2.65	2.47	2.31	2.18	2.06	1.95	1.86
7	3.03	2.80	2.50	2.44	2.27	2.14	2.03
6	3.55	3.22	2.96	2.74	2.54	2.38	2.24
5	4.27	3.81	3.44	3.14	2.89	2.68	2.50
4	5.37	4.65	4.11	3.68	3.34	3.05	2.83
3	7.23	5.97	5.10	4.45	3.96	3.56	3.25
2	11.06	8.34	6.71	5.63	4.85	4.27	3.82
1	23.51	13.83	9.83	7.64	6.27	6.12	4.64

From "Stirling. A Book on Steam for Engineers." By courtesy of The Stirling Consolidated Boiler Co.

MODERN EQUIPMENT AND MANAGEMENT OF A WATER-PIPE FOUNDRY.

By James V. V. Colwell.

Mr. Colwell's study is addressed primarily to the pipe foundry, but the principles apply plainly to a far wider range of work, and many of the elements belong to economical foundry management in any line. The eminently practical spirit of the article will appeal strongly to practical men.—THE EDITORS.

CONSIDERING the extensive use of the type of cast-iron pipe known as "bell and spigot," it is not surprising that its manufacture has created a special and important branch in the foundry business. The many duplicate pieces to be made, the large bulk in comparison to the weight, and the small margin of profit, demand a heavy tonnage output to give a commercially satisfactory plant. For these reasons the business is in the hands of a few manufacturers.

A modern pipe plant must be equipped to turn out from 200 to 300 tons of finished pipe per diem. To do this it must handle almost three times that amount of material, with the least possible amount of manual labor, thus reducing the cost of production fraction by fraction. The cry "Faster—Faster!" that built the steel industry of today is heard in every pipe foundry.

Looking at a piece of water-pipe, more than twelve feet long and yet made as thin as permissible in view of the strain it must carry, the average person cannot realize what it means to construct a mould which will stand the splash and wash of the hot iron dropping over thirteen feet when the pipe is being cast—to set the core in the mould so that the metal is everywhere of uniform thickness. This core is set with a taper fitting the chill plate at the bottom. At the top a ring core holds it central; by this means 4-inch pipe are cast 0.40 inch thick, and 60-inch pipe 2 inches thick. These pipe are always cast on end, or vertically, in pits.

The mould for this pipe is made up of several parts, and each is made by a different gang of workmen. The flask or casing is hinged and is about the length of the pipe. This is placed on a ramming stool, the pattern is set, and the annular space between it and the flask is rammed with special sand; the pattern is then withdrawn,

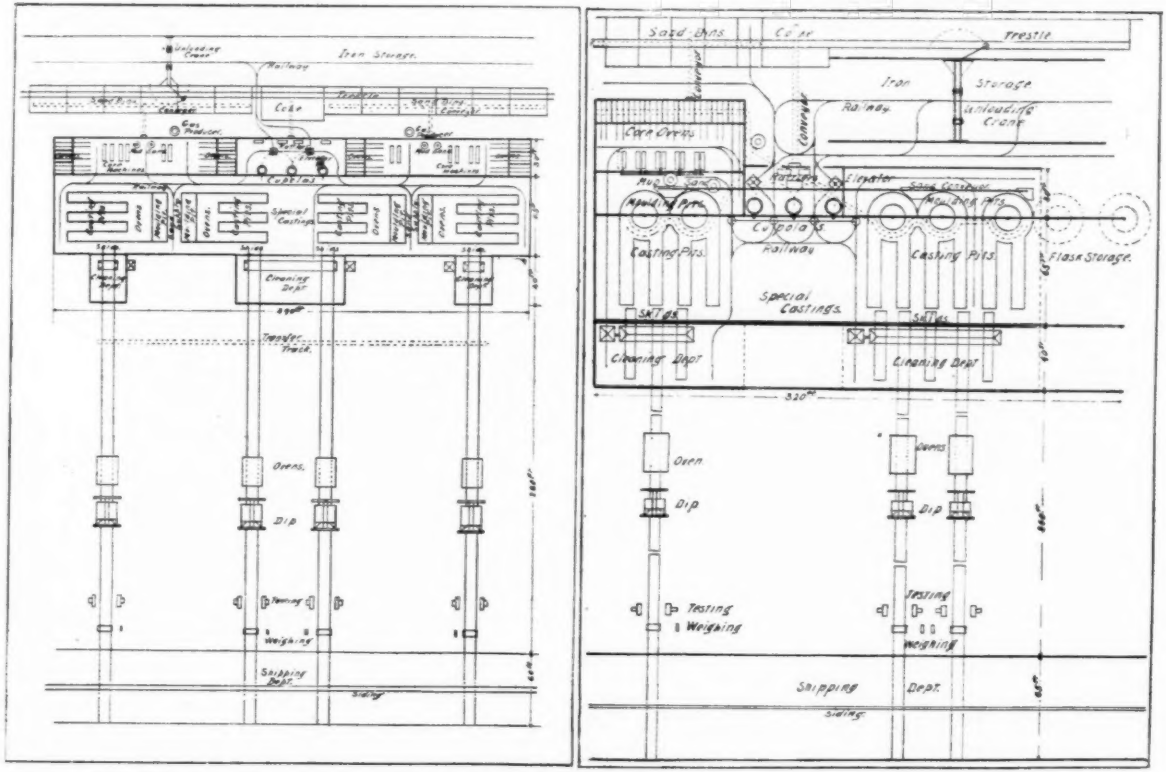
and the sand (if it proves firm and smooth after inspection) is coated with a blackening, which forms a hard crust or skin after it has been dried over a flue constructed for this purpose. This is known as "skin drying." This part of the mould makes the outside of the pipe.

The inside is formed by a core and is constructed in an entirely different way. A pipe filled with vent holes and about two inches smaller than the casting, but longer, with a bearing on each end, is used to build the core upon. This pipe is placed in a core machine, which revolves it while a layer of hay rope is carefully wound on the whole length and secured at both ends. It then receives a layer of mud or stiff clay, well rubbed on (to make it adhere to the hay rope) with a "strike" or "broad gauge." This rough coating is sized to nearly the diameter of the pipe. A crane places the rough core on the core-oven cars; it is then dried in the ovens and returned to the machine to receive the finishing coat, which brings it to the required size. The cores are then blackened the same as the outside of the mould, and returned to the oven to dry over night. A thorough drying of the moulds and cores is most important, as the dampness may come to the surface after they have stood in the casting pits several hours. A damp mould not only means bad casting, but sometimes a man may be severely burnt from that cause.

It is very apparent the simplest and surest means to reduce the cost of production—the one great end in view—is the use of mechanical appliances to do all work possible.

The arrangement of a pipe foundry must be such that every step in the manufacture goes forward and leaves a clear way for the next. The whole plant must be balanced. In almost every case, duplicate machines are a good investment. The loss caused by the plant being held up for a short time will equal in many cases the cost of the machine that caused the trouble.

In these days of electrical power, motors may be utilized to drive machines to perform almost every function. Modern dust-proof motors can be installed at any point in the plant. They are always ready for instant work, requiring but slight attention. An electric motor readily stands an over load, and a limit and safeguard is provided for it by the burning out of the fuse. Considering the constant care of belts and shaftings, their first cost, and the strain on the building where they have large installations, it is not surprising that manufacturers of electric motors are working night and day to supply the demand for modern plants.



TWO STYLES OF PIPE-FOUNDRY ARRANGEMENT—ONE WITH RECTANGULAR PITS, THE OTHER WITH A COMBINATION OF RECTANGULAR AND CIRCULAR.

With an auxiliary prime mover and electric generator, a small power is available at any time for repairs or special work without operating the whole plant, as each department is independent.

The drawings show two styles of pipe foundries, one with rectangular pits, the other a combination of rectangular and circular pits. In both cases electric traveling cranes do all the heavy lifting, closing the moulds, casting, and emptying. In the layout with the circular ramming pits a jib crane handles the flasks during the operation of moulding. With the modern three-motor electric crane, perfect control is assured especially when closing and setting the cores.

All raw material is received on the trestle, with the exception of pig iron; the cars may be dumped directly into their respective bins. By a system of conveyors and elevators this material is delivered into hoppers in the wing of the foundry, doing away with all hand labor. All pig iron is unloaded and stored by a machine of special design which also breaks the pigs and piles them in the storage. As no hand lifting is required in this department the pigs may be broken up smaller than is the ordinary practice, and so may be secured the benefit of closer packing in the cupola. This unloading machine travels the whole length of the storage. It also performs the function of loading from the pile the small cars which go to the charging platform. In this department electricity and the lifting magnet perform nearly every function.

The narrow-gauge railway reaches every corner of the plant. All pig iron and scrap are taken to the charging platform by cars, the cores to the different pits, the refuse to the dump. Three-ton roller-bearing cars are the most economical. A locomotive does all the haulage, the locomotive driver taking care of all shifting.

In a plant working on so close a margin and handling so large an amount of material, the design and location of the buildings for light, ventilation, and physical conditions must be carefully considered. Structural columns and trusses with concrete side walls eight feet high; large window area for light and ventilation; galvanized corrugated iron for the balance of the side walls and roof—these make an ideal building at a moderate cost.

The cupolas are arranged with a three-ton electric jib crane between them, the crane being equipped with scales and a lifting magnet. This arrangement will charge the cupola during the entire heat much faster than can be done by hand, using one-fifth the number of men. The magnet picks up about one ton at a lift from either the car or stock pile; the crane lowers it well down in the cupola

and deposits it at any point desired, without crushing the coke, as is done when the iron is thrown in by hand or dumped in by cars or tubs. This system distributes the iron uniformly in the cupola, a result which is much desired. All coke is drawn from the large storage hopper and is charged by the crane.

To drag the dump from under the cupolas an electric trolley hoist is installed, and this is used also to charge the rattlers or cinder mills, doing way with all shoveling. The car bodies are on trunnions and the contents are dumped into the rattler.

The air supply for melting is furnished by positive blowers driven by electric motors. This makes a compact individual machine.

Various grades of sand and clay are delivered by the elevator to the sectional hopper which is on a level with the charging floor. Below this hopper is placed a continuous measuring and mixing machine which prepares the various grades of moulding and core sand, and also the mud. After being properly prepared each grade is sent to its respective department, either by conveyors or side dump cars of one cubic-yard capacity. This department is under the supervision of one man.

An innovation in foundry practice is introduced in the use of a gas producer to heat the core ovens and to dry the moulds. By this method all coal handling and dirt are centralized, waste in building fires is eliminated, clear atmosphere in the shop is assured, and the proper heat is obtained at all times with the least amount of fuel.

In the core-making departments a traveling crane handles all core pipes and cores. By the proper arrangements of racks to fit the cars and each other, the transfer can be made without loss of time, space is economized, crane work saved, and ovens are kept in constant use.

With the small-size cores it is possible to put thirty to forty cores on a car. One word about core ovens: the location of the flue openings and take-off requires the best judgment to attain good results, viz., uniform temperature and no waste heat.

In the design employing circular pits for ramming and drying, with straight pits for casting, using jib cranes on the columns of the building and heavy traveling cranes over them, the best conditions are attained for moulding, casting, and handling. It takes the least possible floor space for a given capacity; the plant is easily extended or duplicated; the cranes have the least amount of travel, which saves much valuable time.

In the sketch showing rectangular pits only traveling cranes are

used. Over the ramming pit light cranes do all the work; for casting and emptying the flasks, heavy cranes are used, these cranes being required to do considerable traveling.

In both layouts the ramming gang and casting gang work with independent cranes. This gives either gang a chance to set the pace. The traveling cranes take the moulds from over the drying flue and set them in the casting pits. The cores are brought under the cranes on the core cars. Every facility is offered to a large output.

In either style of plant the center of the foundry may be used for special castings, unless made in such quantities that an independent building is required.

In all pipe foundries it is common to have multiple flasks, according to the size of pipe up to 16 inches. All flasks are lifted from center eyes and hinged so that the casting is easily dropped out on the skids at the entrance of the cleaning shop. Storage for the flasks is most conveniently arranged for, at a very small expense, by the extension of the foundry columns and girders. This system makes all the cranes available to handle flasks; there is no rehandling. No time is wasted. This storage can be enclosed at any time to increase the capacity of the foundry.

The arrangement of the skids in the cleaning shop gives ample room for the cleaners and chippers to work. All small sizes of pipe are put on the side skids; the transfer to the center line is made after they are cleaned and chipped. The traveling crane which handles the special castings makes this transfer.

All refuse from the cleaning shop is received in a hopper protected by an iron grating, under the skids; this hopper is emptied at convenient times by a belt conveyor, the material being screened, the good sand returned to the mud mill, and the refuse sent to the dump by the cars.

After the pipe leave the cleaning shop they roll down the skids (about 1½ degrees incline) to the oven, where they are heated before receiving the tar coating which preserves them when in use. When dipped they are about 350 degrees F.; if cooler they do not get the good of the coating; if too hot, the tar is liable to catch fire. When the pipe are taken out of the coating tank, they are scraped of any excess tar, allowed to cool, and then tested hydraulically.

In making this test all air is removed from the pipe, the water coming in from the stationary end of the press. When the pressure has reached 300 or 350 pounds the pipe also receives a hammer test. If found sound in all respects the joint is taken from the press,

weighed on the scales, and marked. Any pipe found defective on testing is broken up, the scrap being sent to the cupola. Sound pipe roll down the skids to the shipping and storage yard. A traveling crane operates over this yard, as it offers superior facilities to a locomotive crane. Cars can be loaded without any shifting, and much valuable room is saved.

To produce an iron to meet the requirements for water pipe it has been found necessary to mix at least four brands or grades. An iron of fair strength, free from blow holes, easily machined, with a gray fracture, is most necessary. These points the engineer considers most. The foundryman goes still further and studies the iron for small shrinkage, and for running qualities, which will make it fill all corners and fillets in the mould. He sees also that it is easily fluxed, so as not to carry slag to the casting.

A first-class chemist should make tests of all raw material and finished product, which should be carefully recorded by the card-index system. These data can be used as a reference at any time; the value of having exact reference in case of dispute or for making comparisons need not be commented upon. The chemist has entire command of the mixing and charging of the iron in the cupola. I might mention here that this goes very much against the grain of the average foundry foreman; the system is always condemned by him when it is first put into use, and generally he is unwilling to give any assistance. The chemist, although a modern addition to the foundry, has proven a most valuable adjunct.

In mixing iron the three elements that require strict attention to keep them within bounds are sulphur, manganese, and phosphorus, the first being the most important. The carbon and silicon are more readily controlled.

Coke should be carefully considered, the tests for sulphur and ash being made as thoroughly as for the elements in the different brands of iron. In the modern method of making 72-hour foundry coke, the sulphur and ash (the two elements that cause the trouble in the cupola) are well controlled by the selection of the proper coal. It is rarely a bad oven appears. The texture, color, and strength of the coke must be carefully judged—the last on account of the weight of the charges it must support in the cupola.

In operating the cupola, complete daily data are kept. The brand and weight of each kind of iron are charged, the amount of scrap, coke and limestone, the time of lighting, the time the blast is put on, and time of dump, are all recorded. The good castings and scrap are

weighed. All elements must be compared for results. From these reports a chart may be plotted which will show the most important features at a glance.

The accompanying drawings do not show the location of the power plant, machine shop, hay-rope departments, or offices. These should be detached buildings, and their location determined by the surrounding conditions.

One word for the foundry—give this department one-half the money which is spent in the machine shop for jigs, templets, high-speed steel, cutting compounds, and modern tools, and the returns will be as large in proportion. The foundry has to get along the best it can, yet it must produce castings to keep the machine shop busy. "Any old flask will do—wedge in a few boards for bars; we can't afford a conveyor and screen for the sand—use the same old barrows—too much expense," is the cry. In no department of manufacture is a greater tonnage of material handled, yet it is impossible to show one with poorer equipment to do the work; there are very few exceptions to this condition.

Moulders today are paid as well as machine-shop hands, so their time must be just as valuable. The same desire to save should be shown in the foundry as in the machine shop. Persons who have studied this know that the foundry foreman appreciates any labor-saving improvement.

When laying out a plant, complete drawings with unit series are as important as details of machinery and equipment. One matter I wish to mention that receives slight notice until it is too late, and the loss in labor each year would have paid the first cost ten times over; that is, the complete individual drawings showing water and sewer mains with all branches and outlets; also proper monuments placed in the ground from which all measurements are taken. With two or three monuments on a plant, and the drawing, one is able to locate everything under ground. New work will always be plotted from the original layout, which can be dated when put in place, giving a complete record. How many times it is necessary to refer to some of the workmen for information of this kind! Under this head are included drawings of the entire plant, individual buildings, location of the machines, motors, passages, as well as the individual machines, showing the clearances and working room necessary. These data should be so complete that all information can be taken from the drawings, and at no time should it be necessary to send the draughtsman into the shop to see how this or that will work out.

A department for cost keeping, stock recording, and supplies for a plant of this magnitude is most essential and requires first-class up-to-date methods. It is an easy matter to have complete and absolute data with very little trouble and small expense, once proper methods have been installed. In cost keeping the several departments are subdivided into groups; all debits and credits are recorded, weekly and monthly balances are readily made up. Every plant has fixed charges which must be offset by credits. The non-producing element must be taken care of as well as the actual man-hour charged against any order. Each shop hour of labor should be credited to that department or machine, power expense charged to the department which was operated, material expense (covering cost of purchase, handling and storage) all charged to the order on which it is used.

All new work, shop improvements, or tools are charged to their respective departments. By this system, any department can be inspected and conditions readily ascertained and the cost of any piece of work determined as soon as finished.

Raw materials and supplies must be accurately weighed or counted, the date of receipt, from whom purchased, and the price paid all recorded; by this method, the amount used during any period and also the amount on hand is shown by the card at a glance. In many cases the purchasing is controlled by the records. There is then little chance of carrying too much finished or semi-finished stock, as a complete check is kept on one of the most expensive departments. When maximum and minimum stock is carried, it is the simplest matter to carry this record on the same card with no chance for guesswork. The cards are an inventory in themselves and do not require expensive help to post them.

Each year brings forth labor-saving devices and systems which are eagerly accepted for trial by manufacturers. Note the difference today in the plant for a contractor who is only temporarily located, compared with what it was ten years ago. His labor is the cheapest, yet he is equipped with the latest labor-saving devices to save the fractions in the cost, which mean profits to him.

The pipe foundry that handles so many hundred tons each day, always in the same routine, should have the best and most modern equipment the engineer is able to produce.

AMERICAN MANUFACTURING METHODS. AN ESTIMATE OF THEIR SOUNDNESS.

By Wm. O. Webber.

Dr. Bell's article in the September number seems destined to inspire a new movement o thought and practice in relation to the engineering industries. We shall be glad, so far as possible, to afford opportunity for discussion to representatives of all views of the question, and we take pleasure now in presenting the comment of an engineer well experienced in American industrial matters who dissents in many points from Dr. Bell's argument.—THE EDITORS.

IT seems to me that Dr. Louis Bell, in his article in the September number "What of America? Do her Manufacturing Methods Imperil her Trade?" makes an assumption which is not entirely justified by the facts, and takes a too greatly pessimistic view.

While it is undoubtedly true, of certain types of manufacture, that the tendency towards cheapening construction has resulted in an inferiority in the article produced, on the other hand I have been greatly impressed with the fact that so many American manufacturing plants, especially in the engineering lines, are reproducing machines of much greater efficiency, bolder in conception, more diversified in their application, and more particularly applicable to the specific requirements of the local conditions of their use than ever. While there is, and always has been, a demand for what we have come to know as the standard article of its type, which has resulted in a department being solely confined to the manufacture of that particular type, by the most approved methods of standardization and special tools, the manufacturer has by no means been satisfied when this result has been obtained, but, as a rule, has immediately started up another department for the development of other more specialized types of the general class of manufacture in which he was interested. He has employed in this new department the highest skilled mechanics obtainable, engaging specialists to study and improve the design, putting the whole work under a superintendent who possesses those rare qualities of executive ability, sympathy and intuition, which alone enable a man in that department to be successful. The results are, for example, that a plant which a few years ago was simply producing the standard American inward-flow type of turbine water wheel, is now successfully putting upon the market the highest types of high-speed, high-pressure, reaction wheels for all conditions.

Again, a number of concerns representing the combination under one management of a number of previously separate lines of manu-

facture, have devoted all of the energy of one plant to a standard line, leaving all of the energy of another one of their plants to the specialized line of work.

It has never been my experience that "standardization * * * means the cessation of active improvement." The American manufacturer is the quickest in the world to adopt an improvement and to make it a standard. It is a significant fact that his willingness to copy European improvements and adopt them, adapting them to American methods of use, shows the progressiveness of the American manufacturer.

The history of American watch-making fully answers the question of the excellence of work done by automatic machinery, as against the highest grade of skilled manual labor. Reference to this particular type of manufacture has been made so often in this connection as to be threadbare, and the example, when quoted, is in danger of being called the "notorious exception" and a "chestnut"; but what, a few years ago, was true of watches solely is now as universally true of machine tools and such things as locomotives.

The fact is that, in spite of the standardization of American manufactures, with its consequent economic results, the American adoption of improvements, whether originating at home or abroad, has gone ahead so fast, and with such economy in the way of efficiencies obtainable from their use, that a consumer can hardly afford to take, as a gift, the five-year-old product of an American manufactory, especially if the consumer is to make use of this product in producing again.

In my mind, the most serious danger which American manufacturing interests have to confront is the idea that a system will ever entirely supplant the ability of a good working superintendent. A complex system of red-tape methods and reports will eventually enmesh a factory in a set of hide-bound methods which are almost impossible of adaptation to new and changed conditions. Time cards pay for themselves; requisition blanks pay for themselves; the rush-order system, under the superintendent's control, will pay for itself; an estimating department for premium work need consist of only one or two bright mathematicians, under a competent superintendent, and production reports can be very simply produced in the same way; a good foreman's clerk will keep all of the piece-work or premium-system time, in proper shape for the pay clerk; and the best driver of a foreman is not comparable in results with the extra cash, in the form of premiums, found in the pay envelope.

EDITORIAL COMMENT

THE definite adoption of the contract system for the construction of the Panama Canal, and more especially of the single contract for the entire work, marks the triumph of the argument which THE ENGINEERING MAGAZINE has steadily urged—the acceptance of the last great principle of plan and execution for which we have fought. Mr. Shonts' letter transmitting the documents to the Secretary of War sets forth as the controlling reason actuating the Commission, the very argument advanced in our editorials of January and February last. The chairman recognizes that, as we put it in the second instance, the canal should be built by "the method by which the greatest engineering works of the world, and all over the world, have been completed—upon plans determined by a competent commission, under the constant and effective supervision of their engineers, but by an organization, a mechanical equipment, and working methods supplied by the contractors."

It is rarely, indeed, that a technical journal sees its solution of a great and complex problem so triumphantly established at every point as we have done throughout the ten-years' active history of this undertaking. In the first check to the stampede to Nicaragua; in the adequate and deliberate study of the alternative routes across the Isthmus; in the searching comparative examination of the Panama and Nicaragua projects, and the sifting of evidence by which the case was indubitably proved for Panama; in the discouraging and at times almost hopeless campaign of education by which the country was at last fully informed and brought to the choice of the Panama route; in the maintenance of patience and common-sense through the weary negotiations with former owners and political influences; in the steadfast and earnest advocacy of the lock-level type, and now in the successful appeal for the application of sound and tried business methods to the construction—in every one of these phases, THE ENGINEERING MAGAZINE took a leading place and threw its influence actively on the side which time has shown to be the right. And in every instance, enlightened public and professional opinion has brought us final justification.

We do not consider the Commission's announced plan perfect. It seems to us to embody serious errors, destined, we fear, (unless sooner remedied) to keep the actual work still burdened with many of the grave faults of bureaucratic method in constructive work, and to reduce many of the advantages of time and money-saving which are the admitted argument for the contract system. These difficulties seem to us most likely to arise through the Government's retention of management of the Panama Railroad and of the Department of materials and supplies, through the limitation of the contractors' liberty and authority in the matter of the list of employees, and through the injection of the eight-hour day provision. But we have faith that these points can be settled so that neither justice nor engineering efficiency need be sacrificed, and meantime the recognition of the principle of contract, and of the inherent necessity of making the entire contract with a single organization which will absorb its own internal difficulties and offer an unimpaired efficiency and an undivided responsibility to the Government—these are so fully and finally recognized that there is no danger the general policy will again be abandoned. The principle is safe, and the details will be adjusted.

We congratulate ourselves on so

brilliant a vindication. We congratulate the Administration on so striking and admirable a recognition of the logic and common-sense of the situation.

* * *

When Mr. F. W. Haskell, in his notable article on the causes of American railway accidents which was published in our issue of December, 1904, stated that engineers habitually ran by signals set against them and were tacitly encouraged to do so by the managing officials (so long as they brought their trains in on time and without accident), he was brave enough to say in the open what many had long known in secret. His reward, and ours, was the usual one—loud and righteous denunciation. But now that the thing has happened once more in the full sight of half a train load of witnesses, a "high official" of the Pennsylvania Railroad acknowledges in a public interview that "trains do run past the cautionary or green signals very frequently at a speed of sixty miles an hour, but we do not consider that to be unnecessarily (?) unsafe." And his next admission is more startling yet: "We frequently flash before an engineer when he is least expecting it the red danger signal *to test his judgment, nerve, and quickness of decision.*" The italics are ours.

If the Pennsylvania Railroad officials are in the habit of crying: "Wolf! Wolf!" when there is no wolf, they need hardly be surprised when they reap the result foretold in the fable. But the most astounding of all is the intimation carried by the words italicized above. If they mean anything at all, it is that the engineer is to judge and decide whether or not he is to obey the red signal, or whether he is to show his nerve by running past it. Possibly after a sufficient course of jugglery with false signals his nerve may carry away his judgment once too often.

Until the red signal is made as absolute morally as a mechanical trip to the air-brake would be physically, the hideous calendar of collisions will be lengthened, and the most perfect signal system will be worse than a waste—it will be a menace, the more imminent the more a false dependence upon it may lead to a divided sense of responsibility and intermittent watchfulness.

* * *

About fifteen years ago there appeared in one of the humorous illustrated weeklies a cartoon representing the idle son of a wealthy father in conversation with his chum. The friend asks: "Are you going to college?" "No," says the youth, "Father is going to have them bring it to me."

At that time such an idea might well be considered a fit subject for jesting; but to-day the point would be altogether lost. It is just fifteen years since Mr. Thomas J. Foster started the system of technical instruction by correspondence which has made the name of the city of Scranton a household word all over the country, and in the celebration of this anniversary the remarkable development of the method has been emphasized in a manner which demands mention. With nearly a million enrolled students, with its own system of text books, printed in its own establishment, and with all the accessories of technical training, modified and adapted to home study, the correspondence school has brought the college to the student, not by having the wealthy father perform the miracle, but by enabling the student himself, usually a man occupied in daily labor, to educate himself, pay his own bill, and elevate his station in life. This great work has been accomplished, not by the munificence of any great philanthropist, but by the close application of sound business principles to a new idea in education, increasing the educational efficiency of the system, while attracting the necessary capital, and paying good dividends to the investors.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

WAREHOUSING AND TRANSPORTATION.

THE NECESSITY OF PROVIDING PROPER WAREHOUSE FACILITIES TO RELIEVE THE DELAYS IN UNLOADING FREIGHT CARS.

A. J. Elliott—St. Louis Railway Club.

AMONG the difficulties with which railway managers have to contend, one of the most important is the demand for cars, on the one hand to haul merchandise, and on the other hand as storage receptacles for goods already delivered. We hear at periodical intervals of the shortage of cars and consequent delays in transportation of crops and other merchandise, and with these demands come complaints as to favoritism and discrimination, with all the attendant train of objections and recriminations. The whole subject is included in the vital matter of the distribution of the products of industry, and the removal of the ancient cry of over-production, a legitimate cry in the days in which it was impossible to equalize the inequalities in production at different points, but a wholly artificial complaint in these days of modern transport facilities.

The real difficulty has been well known and perceived by many economists and engineers in modern times, but it remains to be seen if the evident remedy is to be utilized. Equalization by transportation is not the only element in the remedy, and to it must be added the necessary element of adequate and immediate storage facilities. This whole subject is discussed in an interesting paper by Mr. Ashley J. Elliott, recently presented before the St. Louis Railway Club, from which we make some pertinent extracts.

Speaking primarily for the United States, although the facts certainly will apply to other parts of the world, methods of production and transportation have undoubtedly outrun consumption and reservation. The great harvests are gathered during a few months in the year to supply the cities and densely populated portions for the remainder of the period. The same is true of coal, meat, and many of the great staples, and in every case the periods of maximum supply and maximum demand do not coincide, and some means must be provided for equalization, for storage and distribution.

But warehousing and storage involve the investment of capital and the employment of labor, and it has been found most convenient to minimize these charges by allowing the merchandise to remain in the railway cars for as long a period as possible, and thus let the car be the warehouse, and cut out two stages of the handling. It is against this practice that Mr. Elliott rightly protests, and he shows very clearly that if this wholly unwarranted practice were abolished the complaint of the scarcity of cars for the transportation of merchandise would no longer be heard. There are plenty of cars for the hauling of freight, but there is no adequate supply of cars to serve as storage warehouses!

"A ship or train is simply a warehouse in motion, but how differently the two are treated upon arrival at destination! Marine rules are seemingly inexorable and no one is ever rash enough to combat them. Vessels are for transportation and bankruptcy would face the man who would consult his convenience as to the removal of the lading. If he has a ship and a car, too

he lets the car go and unloads the cargo. Marine demurrage is exorbitant and prohibitive, while car demurrage is nominal and permissive, nor has marine insurance its counterpart on rail. The unloading of vessels is immediately performed and the cry of 'No place for the goods' is never heard, while the unloading of cars depends solely upon how long the railroads and the public will permit them to stand loaded. Railroads should be required to get out of the storage business, to eliminate from their professional vocabulary the terms 'storage,' 'storage period,' 'storage freight,' etc. The public, on the other hand, must stop urging an extension of 'free time' and demand that railroads stick to the transportation business and allow others to engage in the storage of goods. Whenever involuntary warehousemanship is forced upon railroads, their demurrage should correspond to marine demurrage and be sufficiently remunerative to correspond for the interference with public service.

"It is only within comparatively recent years that railroads commenced charging demurrage. Their unwholesome zeal for tonnage caused them to ignore the weighty question of how such tonnage was to be handled by shippers, and the infant evil of free car storage grew to gigantic proportions, before any systematic effort was made to overcome it. The shipping public have not yet grasped the eternal truth that they are perpetuating an insidious and death dealing system when they countenance and encourage storage in cars; death to the whole commercial interests of society. Cars cannot be built for use without limit, nor can tracks upon which they run. Even with subway, surface and elevated, the desirable metropolitan spots of earth are inadequate upon, under and over which, to store the commerce of our cities. Warehouse space, on the other hand, is not limited to three stories, but can reach below and above terra firma as necessities may require."

Mr. Elliott refers to the year 1905 as a production breaker, showing the immense amount of foodstuffs produced and transported in the United States. All means of transportation were crowded to the utmost, but of all the means adopted to relieve the strain there was nothing done to provide improved storage facilities. The demand for cars was greater than ever, but it was not only for transportation, but also for storage, that the cars were demanded. The consumer erpected the railroad to transport the merchandise more rapidly and in greater quantities than ever before, but it also expected it to allow the grain and other supplies to remain in the cars, furnishing both storage bins and sites for the goods to be held until used.

"It is not a question of transportation that is afflicting America's commercial interests today. Railroads have equipment and facilities for transporting all the business that can be offered, provided, after transportation has been completed, their cars are immediately released for further service. And by this term 'immediate' I mean only such diligence as is exercised in unloading vessels. It is very much easier to unload from cars than from the 'holds' of ships: the mechanical appliances are more numerous and the opportunities to use them less circumscribed; for instance, coal, ore and similar freight may be unloaded by dropping car bottoms or turning the car upside down, while from vessels such commodities must be removed by grab or clamshell buckets, a few tons at a time, or in the case of metals, by lifting magnets through the aid of electricity. The devices for handling materials are so numerous, ingenious, simple and inexpensive, and their use so beneficial in releasing cars, that failure to install and use them is both a public and a private shame. From gravity, side hill and trestle systems, which require no machinery, to the most elaborate moving-platform, link belt, electrically operated plant, the one result is obtained, namely—the immediate unloading of cars.

Many excuses have been advanced as to the difficulties of storing merchandise, but these have vanished when the real occasions have arisen. It was said that coal could not be stored because of the danger of spontaneous combustion, but with the advent of the coal strike the storage of coal was seen to be safely accomplished, and we have noted elsewhere in this issue the existence of scientific methods which afford ample protection against the danger of fire from the spontaneous ignition of soft coal. Industry no longer depends

upon scarcity conditions. General prosperity demands that the basic materials of industry be accumulated far enough in advance to prevent scarcity and scarcity prices.

"The Interstate Commerce Commission has decreed that there shall be no discrimination or elasticity in the time allowance for the removal of goods from a railroad company's posesssion; that they must state in their tariff the time to be allowed and enforce the rule uniformly. It is self-evident that more cars will be required to move a given quantity of freight in a given time, if delays at destination are permitted, and more cars means more expenses—which is always reflected in the rate—but over and above all that, it means more congestion at terminals, which is the real difficulty now, and more cars would aggravate rather than remedy this objectionable condition. Liverpool tells us how hungry the world is and how much is needed to satisfy its appetite, and how much will be paid in exchange for being fed. The potent factor of morning quotations governs largely the time of seeking transportation. If the price is right this morning and 100 Iowa farmers accept the bid of one Chicago consumer and cars are promptly furnished, the trouble will arise at destination unless that consumer has facilities for unloading in one day, all that is shipped to him by those 100 farmers in one day. The cry for more cars for shipment to an industry already congested, means the withdrawal of that many more cars from service. Manufacturers buy when goods are cheap, and then play and pray for long time for unloading. Railroad equipment *must* not be used for storage purposes and those concerns which are amply equipped to handle their receipts promptly, and all representatives of interests which do not delay cars, should join hands with those who are seeking to curtail the abuse and to enhance the legitimate use of these vehicles of commerce."

PRACTICAL METHODS OF TESTING COAL.

SUGGESTIONS FOR THE TESTING OF FUEL COALS OF THE EASTERN INTERIOR BASIN OF THE UNITED STATES.

A. Bement—Western Society of Engineers.

WE have referred more than once in these pages to the important and valuable investigations under the conduct of the United States Geological Survey upon the fuel value of American coals and lignites. This work, originally begun in connection with the exposition at St. Louis has fortunately been continued with an additional appropriation, and the commercial value of the results has already made itself felt. The method employed in these tests include chemical analyses of the various coals, calometric determinations of heating power, and evaporative tests by combustion under steam boilers. To these were added washing tests, cooking tests, and tests of suitable fuels in the gas producer. The evaporative tests were and are being conducted according to the code of the American Society of Mechanical Engineers, and the entire work commands the fullest confidence of the engineering profession as to its accuracy, impartiality, and usefulness of the results.

In addition to these tests conducted by the United States Geological Survey, there has been arranged a series of independent coal tests by the Illinois Geological Survey and the Engineering Experiment Station of the University of Illinois. These tests will in no way conflict with the larger work of the National survey, and it is impossible to have too much information about such an important material as fuel coal. It is also possible that the latter trials may be conducted along a somewhat different line of inquiry, a subject which is already being discussed. It is with reference to this work that we review here a paper by Mr. A. Bement before the Western Society of Engineers, discussing the conditions desirable, not for scientific research, but rather for commercial specifications and inspection.

Mr. Bement believes that for the requirements of the purchaser it is desirable that determinations of moisture, volatile matter, fixed carbon, sulphur, and evapora-

tive power, be abandoned, and that the only essential requirements for the purchaser are the statement of the percentage of ash in the dry coal, the size of the coal, and the heating power of the pure coal in British thermal units.

Taking these up in order Mr. Bement gives his reasons for this opinion.

"Moisture is a great and uncertain variable. It not only differs in various coal seams as the coal lies in the ground, but is affected in fuel as received in shipment, by conditions of weather, temperature and time the coal may be in transit. It is approximately correct, however, to say that each coal seam has a characteristic moisture content of its own, which is uniform over at least very considerable areas, but the after influences above mentioned change it, so that there is no assurance of what it may be except under specially defined conditions.

"Therefore, the producer or coal dealer can exercise no control over moisture, and as the prime object of fuel inspection service is to insure that the customer is served to the best ability of the dealer, specifications and tests of moisture in coal delivered can offer no protection to the purchaser. As before mentioned moisture varies in different coal seams; for this reason it might appear that its determination would indicate the seam from which the coal came. This is not true, however, for reasons above mentioned. If tests are expected to identify the seam which produced the coal other means must necessarily be employed."

When coal is delivered by wagon the moisture may be found high because the coal has been wetted by the dealer, either for the purpose of increasing the weight, or more probably, to allay the dust.

In any case the determination of moisture after delivery proves nothing to the purchaser, and might as well be omitted.

The question of volatile matter is not of material importance to the purchaser when the coal is to be used for steam making and not for the manufacture of gas or for cooking in by-product ovens. The real meaning of the term "volatile" matter is open to discussion and Mr. Bement shows that it is open to various inferences.

"The best conclusion is that coal is a complicated hydro-carbon which breaks down in distillation into various fractions, depending upon temperature and duration of heating period, and that the difference in coal of this basin is not greater than that due to the varying effect produced by the volatilization test itself; or, in other words, the variation may be caused by the test rather than by the composition of the coal. Thus the volatile matter test is not sufficiently accurate to be of service in this case. It is, of course, true, that it would distinguish between bituminous, semi-bituminous and anthracite coal, but one may do this merely by inspection without any test whatever."

The principal interest which the presence of volatile matter has to the manufacturer is that fuels high in volatile matter will make smoke if burned in unsuitable furnaces, but that, with properly designed furnaces it will show a good efficiency with smokeless combustion.

The question of the amount of fixed carbon in a coal is of importance if the coal is to be used for making coke, but for steam coals it is merged in other, and more important properties. The same is true of the presence of sulphur, it is of extreme importance in metallurgical work, and of little or no value in steam making.

Mr. Bement is especially emphatic in his views regarding the unsuitability of evaporative power as a qualification of a coal for steam raising properties, and in discussing it he uses the following positive language concerning the evaporative power of a coal.

"This is something which should never, under any circumstances, become a feature of specifications or guarantees, for several very important reasons. In general, too many variable factors enter into the problem. For example, boilers differ, some being more efficient than others, absorbing greater or less amounts of heat from the coal for reasons due to their individual superiority or inferiority. Then furnaces differ greatly; in some cases all of the volatile matter may be burned; in others, a large portion be wasted. Again, fire grates differ in like measure, causing varying losses of fuel which falls into the ash pits, and the combination of grate and furnace has an important influence on the ex-

cess of air which necessarily enters, and for this latter reason, also, the useful result obtained from the coal is affected to a marked extent. The above refers to the characteristics of the apparatus itself, but at this point another and most serious variable must be considered, that of the personal equation of the fireman or furnace operator; therefore it is apparent that in such a test, one may be unable to discover whether the result is due to the fuel, the peculiarities of the apparatus or its manipulation. In the case of a coal purchaser who does not realize these facts, the result is always attributed to the object in view, which is, in such instance, to determine the value of the coal. If he had wished to discover whether he employed a good fireman or not, the experiment would have been precisely the same, and he would have then considered the result due to manipulation. It is not only the above features which have an important influence, but the character of the load on the plant is a matter of great moment. In a works where boilers run steadily for 24 hours, the result secured, everything being equal, will be much better than in one where the work is necessarily interrupted by stoppages at noontime, shutting down at night, or with peaks of load as in electric railway service. Any one of the foregoing causes may exercise a greater influence on the evaporative result secured than that due to variation in fuel."

Passing from these properties of a coal, which Mr. Bement believes it would be well to abandon, in commercial specifications, he passes to the tests of which he approves, the first of these being the amount of pure coal in a fuel.

"For better understanding, it is desirable to consider coal as the chemical combination of certain elements which are principally heat producing. The association of ash and moisture with these, results in an aggregation which may be designated as fuel, although generally called coal, which, from this standpoint, however, is not correct, because neither ash nor moisture produce heat. The expression, pure coal, is the equivalent of what has erroneously been called combustible, the pure coal containing all of the combustible matter, and some water of composition and nitrogen which are not combustible, but as these two ingredients are associated chemically with the combustible, the ultimate conception of coal is covered by this term, pure coal. Thus in the heating power determination, it is more to the point to base results on the pure coal than on any of the fuel mixtures, illustrated as follows:—Let it be assumed that in one case the B. t. u. per pound of dry coal is 13,250, and in another 12,450, from which it would appear that the two lots of fuel were different, but if the percentage of ash content in each is known, and the first sample contained 7 per cent and the latter 12 per cent, it appears that each sample has a pure B. t. u. of 14,250, or, in other words, that the coal is the same in each, there simply being more ash associated with it in one case than the other. Basing the heating power determination on pure coal has another very important advantage, as it enables one to judge of the accuracy of analysis, because when the heating power and the source from which the coal comes is known, there is evidence indicating whether or not the analysis has been correctly performed, because, if it has not been, it will be shown by the B. t. u."

In determining the proportion of ash in a coal, Mr. Bement believes that it should be considered as a percentage of the dry coal instead of the moist fuel, because this is the only way in which different lots of fuel may be placed on a comparable basis. Moist coal is not burned in any case, the moisture being evaporated; neither is the dry coal burned, it is the pure coal which is consumed, the ash remaining, and the pure coal alone making the fire.

The value of a fuel depends very largely upon the size of the pieces, the ratio of increase being greater than the mere heating power, up to egg and lump sizes. That is, small pieces, containing the same amount of heat as larger ones, are really of less value than the larger coal. The best actual size depends upon local conditions, such as the force of draft, the kind of stoker or grate, the method of firing, etc., these all being features which must be left to the judgment of the engineer.

These views of Mr. Bement are of much interest, especially as they doubtless express the opinions of numerous engineers

and coal users in the portion of the United States to which he specifically refers. At the same time it must be realized that these elements do not represent the actual scientific properties of the fuel in such a manner as to render them comparable with other, and totally different fuels, such, for example, as liquids or gaseous fuels. The methods adopted by the Geological Survey carry the matter much farther back, to the ultimate properties of the material, considered as a latent source of energy, and hence it is a matter for congratulation that the coals of Illinois, as well as of other parts of the United States are to be tested by the National government in the methods best adapted to reduce them all to a comparable basis. In the meantime the work of the Illinois Geological Survey and the Engineering Experimental Station of the University of Illinois will be welcomed as a useful auxiliary to the larger and more important scientific investigations of the United States Geological Survey.

STANDARDISATION IN ENGINEERING PRACTICE.

THE FORMATION, METHODS, AND RESULTS OF THE WORK OF THE BRITISH ENGINEERING STANDARDS COMMITTEE.

Sir J. Wolfe Barry—British Association for the Advancement of Science.

THE excellent results which have thus far been attained by the Engineering Standards Committee give especial interest to the account of the formation and general method of procedure of that body as described in a paper presented before the British Association for the Advancement of Science by Sir John Wolfe Barry at the recent meeting at York.

One of the earliest advocates of standardisation in England was undoubtedly the late Sir Joseph Whitworth, and it is interesting to note that he took as an illustration for the necessity of standardisation the inconvenience existing in his day between the sizes of candles and the sockets of candlesticks. Today one of the important subjects for standardisation is the shank and socket for the incandescent electric lamp, so that it is the thing rather than the principle which has changed.

Whitworth took up first the question of standard screw threads for bolts and nuts, the result being his well-known system, used throughout the British Empire, and in many other countries as well, and Sir John Wolfe Barry notes as one of the advantages of standardisation that the Whitworth screw threads are largely used in countries where, for all other dimensions, the metric system is in vogue.

At the time of the establishment of the National Physical Laboratory, Lord Salisbury made some remarks about the desirability for some recognized and authoritative body to determine standards for practical use. The result was the suggestion, by Sir John Wolfe Barry himself, of the matter to the Council of the Institution of Civil Engineers, by whom the subject was gradually extended to include the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers. Subsequently, with the granting of a government appropriation in aid of the work, there have been added representatives of the various government departments, so that practically all the various fields of engineering work are well covered.

"It was felt from the first that a most important point in any proper scheme of standardisation was to avoid the danger either of crippling invention or perpetuating forms or processes which in course of time might become obsolete. Accordingly it was recognised in the first motion made at the Institution of Civil Engineers that there must be provision for a continuance of the existence of the body which might be formed to take the matter in hand. It was not enough to standardise the most approved forms and processes of manufacture, but it was urgently necessary to provide for future improvements.

"To carry out this view the main and sectional committees continue in existence after their reports have been made, and an opportunity is afforded once a year to the sectional committees of revising the specifications issued by them, so as to insure that the standard specifications are kept thor-

oughly apace with the progress made from time to time in engineering science, so that there should be no stereotyping of design or practice.

"Standardisation may roughly be divided into two classes, that dealing with shape and form, and that dealing with material. In regard to shape and form, the guiding principle of the committee has been to place at the disposal of the engineer such shapes and sizes as may reasonably be needed by him to meet the general requirements of every-day work, and they have carefully avoided indicating to the engineer how and when these shapes should be used, or what particular strains should be allowed in the material composing them. The committee have felt that this is a question entirely for the engineer, and that he alone must decide what stresses may be allowed in the structures which he is engaged in designing.

"In one instance only have they departed from this principle, and that at the special request of the Secretary of State for India, who desired them to lay down certain specific types of locomotives for use on Indian railways, which it will be remembered, unlike the railways in this country, are under direct government control."

It was the original plan of the committee to deal only with the standardisation of shapes and details, but it has been found desirable to take up also the subject of materials, this involving the preparation of standard specifications, covering the materials more generally used in engineering. The multiplication of specifications prepared by consulting engineers, and differing from one another often in unimportant details, precludes the unification of the process of manufacture, and it is believed that this difficulty would be removed by the issue of standard specifications.

"It must, of course, be borne in mind that every advantage is accompanied in a lesser or greater degree by some disadvantage. For instance, should standardisation be pushed too far, it might in some instances stultify design or retard progress of invention; but provided that it is clearly understood that special circumstances must exist which warrant special designs, and as long as standardisation is confined to broad principles, and the standards laid down are sufficiently numerous, the advantages must immeasurably outweigh the disadvantages. Exceptional cases may no doubt exist where the use of some particular form of angle or channel is justified, and where the expense entailed in cutting special rolls, and delay in manufacture by the consequent changing of rolls, is warranted; but in the vast majority of cases an engineer can equally well use standard sizes without in any way cramping or impairing his design. In the case of steel, standard sizes are also very valuable to trade, as since they avoid the necessity of cutting new rolls, they can be rolled to stock, thus obviating any interruption in process of manufacture or delay in delivery."

One of the most important advantages accruing from the adoption of standard sizes, especially for rails and rolled structural shapes, is the lack of delay in filling orders. When the engineer specifies some special shape, requiring the construction of special rolls, the cost and the time are both greatly enhanced. If, on the contrary, he examines the standard shapes, and selects that which most nearly meets his requirements, he may either find the material already in stock, or else have it manufactured at the lowest price with the minimum of delay. This fact alone may result in keeping in the hands of home manufacturers orders which might have gone abroad.

"Owing to continuity of existence, there is now in the British Standards Committee a body to whom engineers and manufacturers can refer when they desire that subjects for standardisation should receive consideration, and further, this body is distinctly representative, drawing its members from all parts of the kingdom, and from every section of those affected, insuring continuity of policy and adhesion to the standards laid down from time to time by government departments and public companies, in a manner never previously obtained.

"Though less apparent at first sight, perhaps one of the main advantages of the appointment of the Standards Committee has been the fact that it has provided an impartial tribunal of a very high technical order, where conflicting interests, often of large importance, and involving considerable financial considerations, can be thoroughly and impartially thrashed out. The accredited representatives of the various in-

dustries are certain of obtaining a patient hearing, and where divergent interests have to be reconciled, of arriving at a compromise best suited to meet the needs of both parties concerned."

This whole subject of standardisation is one which demands the closest attention of the engineer, the scientist, and the manufacturer. Kept within proper bounds, it may be made a great help, both in design and in construction, but if allowed to extend too far, and to perpetuate forms and dimensions which should be superseded, it may become a serious bar to progress. As it is now constituted, the Engineering Standards Committee should be a means of great good to the work of the engineer and manufacturer. What it may become in the future depends almost wholly upon the spirit in which its work is conducted.

THE METRIC SYSTEM IN FRANCE.

DIFFICULTIES EXPERIENCED IN THE EFFECTIVE SUPPRESSION OF THE COMMERCIAL USE OF THE OLD UNITS OF MEASURE.

Gaston Domergue—Circular of the French Minister of Commerce.

IN the course of the various efforts which have been made to extend the use of the metric system of weights and measures in Great Britain and the United States by further legislation than that which has already legalized the employment of the system, the term *adoption* of the metric system has been frequently employed. It is difficult to say exactly what is meant by adoption, but it is evident that if any further legislation is enacted it must be of a more vigorous nature than the mere permissive laws, which, after forty years, have produced little or no effect. For this reason it may be interesting to examine what measures have been taken to *adopt* the metric system in the country of its origin, and to see how effective the legislation has been; and in this connection we may refer to an official circular recently issued by M. Gaston Doumergue, the French Minister of the Department of Commerce, Industry, and Labor, this government department having, among other duties, the enforcement of the laws relating to standard weights and measures throughout France.

At the time of the original production of the metric system in France, at the close of the eighteenth century, various laws were passed, the enactment of April 7, 1795, being generally considered the fundamental one. This famous law did not contain any compulsory clause, leaving that feature to be provided for subsequently, and even the law of December 10, 1799, simply directed that the platinum metre and kilogramme deposited with the *Corps Legislatif* by the Institute should be "the definitive standards of measures of length and weight throughout the entire republic."

In 1812, by the Decree of February 12, Napoleon authorized the Minister of the Interior to issue rules providing convenient fractions and multiples of the metric units, "accommodated to the needs of the people," and on March 28 of the same year these rules were issued, these permitting the employment in commerce of a toise, two metres in length; a foot, equal to one-third of a metre, but divided into twelve inches, and the inch divided into 12 lines; a livre, equal to one-half a kilogramme, but subdivided into 16 ounces, etc. This law was intended to "faciliate and accelerate the establishment of uniformity of weights and measures in our Empire," the idea being to retain, for the time being at least, the old names, but to give the fundamental units actual metric values, and thus render possible the disappearance of the old Paris foot, pound, etc.

As a matter of fact, however, the desired result was not attained, and hence, when the subject was next brought up, in the Chamber of Deputies in 1837, a most animated debate took place. In order to overcome the popular repugnance to the metric system, Martin, the Minister of Commerce under the administration of Guizot, introduced a *projet*, which, after numerous amendments, became law on July 4, 1837, and still remains on the statute books of France. This act repealed the decree of February 12, 1812, but permitted the use of the old denominations until January 1,

1840, after which the possession of weights and measures other than those of the metric system was made a penal offense, under the law against the possession of false weights and measures. Further, the use of any of the old *names* of units was forbidden in any public act, poster, or advertisement, with a fine of 20 francs imposed for each offense for any public officer, or of 10 francs for any private individual, this including, for the latter, the use of the old denominations in any signed private communication, as well as in advertisements, or other printed matter, the fine of 10 francs to be imposed for each complaint. The official inspectors of weights and measures were also authorized to seize any instruments of weight or measure which they might find in the old system, or in any system other than the metric. This is how the metric system was finally *adopted* in France!

Since the first day of January, 1840, this law has been in force. How well it has accomplished its purpose appears in Circular No. 111 issued in April, 1906, by the present Minister of Commerce, M. Domergue, the successor of M. Martin, under whose efforts the law of 1837 was put through.

M. Domergue has evidently grown very tired of trying to use the method of fine and seizure to compel the French merchants to abandon the old denominations, and he has decided to try the milder plan of persuasion. His idea is to secure the cooperation of the various Chambers of Commerce of the different cities of France, and to this end he has issued this Circular No. 111, which has been sent to all the Presidents of the Chambers of Commerce, and also placed in the hands of the Government Inspectors of Weights and Measures for their guidance. We give a translation of the entire circular, as it tells its own story most effectively.

"The Minister of Commerce, Industry, and Labor:

"To the President of the Chamber of Commerce at ———

"In order to effect the total suppression of prohibited measures and weights my Department has been compelled, upon various occasions to give instructions to the Service for the Verification of Weights and Measures to make seizures of these irregular articles, in accordance with the law of July 4, 1837. Notwithstanding all its efforts however, the Service has not been able to accomplish the desired result. This situation seems to proceed from the persistent manner in which certain trade bodies continue to make use of the prohibited denominations, thus encouraging the employment of the forbidden weights or measures.

"Thus, I have found that in a number of industries the prohibited matter is contained in advertisements, prospectuses, catalogues, etc., exchanged by merchants and sent to their customers. Doubtless the merchants themselves will maintain that the present state of affairs should be left undisturbed, for fear of losing orders, and they will continue to use the inch and the line in describing their products.

"In most cases it is the description, rather than the dimension which is depended upon, for the sale of the articles. Nevertheless this unfortunate practice interposes obstructions to the efforts made by my Department to effect the complete disappearance of the inch and the line, and of other weights and measures contrary to the metric system.

"I do not consider it advisable, at the present time, to enumerate the industries or professions which continue to use the forbidden denominations, but they are still numerous, and for the most part known to the members of your association. I have no longer thought it well to order the agents of the Service to enforce strictly the instructions of Article 45 of the Ordinance of April 17, 1839, which directs them to report to the Registry authorities all infractions of the law relating to the use of the prohibited denominations which they may discover in posters or advertisements. If this method were followed, I realize that a considerable number of occupations would be inconvenienced, and the commercial operations of manufacturers thrown into confusion.

"Under these conditions, I have considered whether it might not be practicable to succeed in modifying these usages by some other means than those of repression; that is, by addressing myself to the Chambers of Commerce, requesting their mem-

bers to use their influence, both upon merchants and customers, to induce them to abandon these practices, which are contrary to the requirements of the law.

"I am persuaded that such an appeal, made to them under such circumstances by the Government, will not find them indifferent, and that they will take united action to aid in causing the disappearance of the last vestiges of the denominations adopted before the creation of the metric system.

"In any case I will be obliged to you for an acknowledgment of the present circular, copies of which have been sent to every Inspector of weights and measures, who, being in daily contact with manufacturers and merchants, will be able to furnish you with valuable information concerning the commerce and professional work of your district in which the old denominations are yet in use."

GASTON DOMERGUE,
Minister of Commerce, Industry and Labor.

In this connection it may be of interest to quote from a very conservative review made in the pages of the *Figaro*, one of the most widely circulated newspapers of Paris, upon the article of Mr. Suplee concerning the proposal to force the use of the metric system in the United States, appearing in THE ENGINEERING MAGAZINE for May of this year. The author of the review, M. G. Labadie-Lagrave, while deploring the difficulties which have prevented the general use of the metric system in the United States, proceeds:

"Unfortunately, this is a case in which an extreme degree of civilization is an obstruction to progress. In a country in which the industries are but slightly developed, a change in the system of measurement may upset retail trade for a few years, but it will not involve the enormous sacrifice necessary in the reconstitution of a gigantic manufacturing system, the products of which are sold over the entire globe. Upon the day when the Americans adopt the metric system, they will be obliged to reconstruct anew all the tools with which they manufacture their products, now measured in feet and inches. Everything will have to be changed, from the thread of a screw to the driving wheel of a locomotive. Doubtless the advantage would be appreciable, but the cost would be very great."

This is how the proposition strikes the French reviewer, and we have seen above how the effort has struck the perplexed Government Minister. And yet there are those who tell us that the difficulties of the change would be trifling!

HIGH-SPEED ELECTRIC MACHINERY.

THE INFLUENCE OF THE STEAM TURBINE UPON THE DESIGN AND CONSTRUCTION OF DYNAMO-ELECTRIC MACHINES.

Silvanus P. Thompson—Society of Arts.

IT is generally conceded that the best results in any engineering undertaking are obtained by the complete co-ordination of all the elements of which it is composed. This result, however desirable, is by no means always attained, and one of the most conspicuous examples of the manner in which two important departments of engineering failed to co-operate is found in the parallel development of the dynamo and the steam engine. This fact is well brought out in a lecture delivered before the Society of Arts by Professor Silvanus P. Thompson upon problems in electric design, as affected by speed and rated output. Professor Thompson examines the historical development of the generation of electricity from steam power in an interesting manner, showing how the two departments of applied science were working for many years at cross purposes.

The early dynamos were of small power, and ran at high speeds in order to give the required voltage. The steam engines of that day nearly all ran at slow rotative speeds, and in nearly every case the connection between the engine and the generator was by belting.

"The pictures of projected central stations of the early eighties are most instructive. They usually show a single large steam-engine driving a main shaft from which a large number of small dynamos are driven by belts, with or without

countershafts. The great majority of early American stations were actually fitted upon this plan. Nevertheless it was foreseen that, sooner or later, direct driving must supersede belt driving, and this tendency made itself evident in various directions. Mr. Gordon, when designing the electric lighting plant for Paddington Station in 1882, constructed two-phase alternators direct-driven from engines of massive type, each unit being of 420 horse-power at 164 revolutions per minute. These engines and the alternators have been in continuous work from 1883 to the present date. At the Vienna Exhibition of 1883, Messrs. Ganz surprised the engineers of that time by producing a fly-wheel alternator. That is the alternator was built with a revolving field-magnet having a crown of radiating poles projecting from the rim of the fly-wheel of a large horizontal engine. The horse-power was 120, the speed 230 revolutions per minute. About the same date, as recorded in vol. iii. of the American Society of Mechanical Engineers, Mr. Edison designed his 'Jumbo' pattern of dynamo for direct-driving by a Porter-Allen engine, using steam at 120 lbs. per square inch from a Babcock-Willcox boiler. The indicated power was 168.4 horse-power, the speed 350 revolutions per minute, and the total weight of the dynamo 44,820 lbs.

"These were, however, exceptions. In the United States, hundreds of lighting stations grew up in which the most conspicuous feature was the leather belting: for the engine builders had their standard slow-speed engines, and the dynamo builders their standard high-speed dynamos, and neither would go out of their way to adapt their manufactures to the needs of the other. The large stations, such as the West-end Station in Boston, in the early nineties, were marvels of engineering at cross-purposes.

"It was clear that development might come in either of two directions: either the electric generator might be designed to suit the slow-speed engine, or the engine might be designed to suit the high-speed generator. The former of these courses prevailed on the Continent, particularly in Germany, where the large slow-speed type of generator was evolved by the houses of Siemens and Halske, Schuckert, and the Helios Company, as well as in Austria by Ganz, and in Switzerland by the Oerlikon Company."

In England the development of the small, self-contained high-speed engine, by Willans & Robinson, Bellis & Morcom, and others, provided power for dynamos of moderate size and high rotative speed, but with the adoption of the alternating current, especially after the introduction of polyphase plant, the demand for large units increased, and with this came the introduction of the marine type of engine, direct-connected to the generator.

Professor Thompson refers to the exhibits at the Paris exposition of 1900 as showing what appeared at that time to be the concentration of all engineering experience on a final type.

"Yet all the while a new development had been in progress, which though not much in evidence at the Paris exposition, had nevertheless been spreading quietly in England. The steam turbine had dawned upon the horizon, and had, indeed, for more than ten years, been in active evolution. Steam engineering had indeed been necessarily progressing towards higher speeds, even with reciprocating engines. For thermodynamic efficiency implied working between wider temperature limits, and as the lower temperature could not be reduced below that of the water of condensation, the necessary course was to increase boiler pressures and superheat the steam. Higher superheat involved new difficulties respecting lubrication and the expansion of the working parts. It necessitated higher piston velocities. To get higher piston velocities resort must be had to increased number of revolutions. And the high-speed reciprocating engine was found to offer advantages of its own, in economy of space, greater evenness of turning moment, and convenience of enclosure of the moving parts. But even so the high-speed reciprocating engine soon began to find a formidable rival in the steam turbine, which with its huge peripheral velocities, its simplicity of lubrication, economy of space, and absence of vibration, offered certain advantages over any reciprocating engine, however good."

Thus the development of the steam engine has led to a return to higher rotative

speeds, and the electrical engineer has in turn been obliged to follow, and design generators adapted to the new conditions.

Professor Thompson devotes the remainder of his lecture to the elucidation of the principles of dynamo design, taking into account these latest demands, but it is not our intention to discuss this portion of his paper. The point now to be emphasized is that no final result can be reached, but that in any case the best result should be attained by the engine-designer and the electrician working together; ceasing the endless game of trying each to overtake the other. Just now the steam turbine appears to be the coming engine, and the electrical engineer is busy attempting to plan his machine to meet the conditions which it imposes. To-morrow it will be the large, slow-moving gas engine, fed by furnace gases, which will be calling for a dynamo suited to its requirements. Before long the gas turbine may be in the field, with rotative speeds beside which the steam turbine will appear sluggish, and again it will be the task of the electrical engineer to meet the change in the motive power. Possibly the final form will be the abandonment of any mechanical device between the fuel and the current, but whatever may come, surely it is about time that the two departments of engineering got together, and ceased this fruitless game of chasing and dodging each other over the changing range of possibilities.

THE TUNGSTEN ELECTRIC LAMP.

A REVIEW OF THE DEVELOPMENT OF THE TUNGSTEN FILAMENT FOR USE IN INCANDESCENT ELECTRIC LIGHTING.

Electrical World.

DURING the past few years there has been a determined effort to find some material which should serve as a more satisfactory filament than the carbon thread in the incandescent electric lamp.

We have already noted in these reviews the work which has been done with the osmium and the tantalum lamps, and of late much has been published in a fragmentary way about the advantages and possibilities of tungsten as a material for lamp filaments. In a recent issue of the *Electrical World* there has been collected a concise review of the various notes about the tungsten lamp which have appeared of late, this forming a valuable digest of information not readily found in any one place elsewhere, and from this source we abstract some of the more interesting points.

"While tungsten is considered one of the rare elements, tungsten compounds are of considerable use. Sodium tungstate is largely employed for impregnating fibres to make them fire-proof. It is also used as a mordant in dyeing. Tungsten bronzes are largely employed as bronze powders and pigments. The chief consumption of tungsten in recent years has been, however, for high-speed tool steels and for hardened steel for armor plates and large guns."

The demand for tungsten in the steel industry has naturally caused an advance in the price, the market value of concentrates containing 60 per cent of the oxide having risen from $2.00 per unit, or hundredth of a ton, to $6.00 per unit.

"At the present time there is but one district in the United States that is being developed as a business proposition and on a large scale, and that is the Boulder County, Colorado, district. There are, however, numerous localities throughout the United States where tungsten minerals have been found, but there are only a few thus far known that give promise of containing the metal in quantity. Only small quantities of ferrotungsten alloys or tungsten salts are imported into the United States, because at the present time the European markets utilize practically all of the tungsten that is produced in foreign localities, largely in Australia and Peru.

"The melting point of pure tungsten has always been stated to be very high, though it does not seem to have ever been accurately determined. As a matter of fact, from experiments recently made with pure tungsten by Just and Hanaman it appears that tungsten behaves like carbon, since (under ordinary conditions of pressure) it volatilizes directly without passing through the liquid state. But the temperature at

which carbon volatilizes is considerably lower than that of tungsten. That means that a tungsten filament can be operated at a considerably higher temperature than a carbon filament, and from the thermodynamical laws of radiation, especially from the Stefan-Boltzmann law of total radiation and from Wien's displacement law, we can therefore conclude *a priori* that the tungsten lamp will be much more efficient than the carbon lamp."

The natural difficulty in the making of a tungsten incandescent lamp is the production of a filament of metallic tungsten. Several methods have been tried for this purpose, mainly based upon the substitution of the tungsten for carbon or some other foundation.

The method of Just and Hanaman, of Vienna, starts with the idea of producing a coating of tungsten on a core of carbon.

"The oxychlorides of tungsten or molybdenum, when heated to red heat, are reduced by hydrogen, forming metal, hydrochloric acid and water. If, therefore, a carbon or metallic filament is heated to incandescence in an atmosphere of tungsten oxychloride vapor with an excess of hydrogen, the reduced tungsten is deposited on the carbon or metallic filament, and the resulting filament consists of a core of carbon or metal, with a cover of tungsten.

"Experiments proved, however, that under certain conditions the reaction proceeds in a different way. If a carbon filament is electrically heated in tungsten oxychloride vapor in presence of very little hydrogen, it is by and by transformed into a filament of pure tungsten. The carbon is oxidized to carbon monoxide and carbon dioxide, the chloride combines with the hydrogen and the tungsten is deposited in the place of the carbon.

"When the carbon has been entirely replaced by tungsten, it is advantageous to increase the quantity of hydrogen and more tungsten is now deposited on the tungsten filament, hydrogen being the reducing agent, while carbon does not participate in the reaction.

"The conditions under which the reaction occurs with the oxidation of carbon are an excess of oxychloride, the presence of very little hydrogen and a high temperature of the filament. With an excess of hydrogen and at too low a temperature of the filament, carbon does not participate in the reaction.

"Exactly the same reactions take place with molybdenum instead of tungsten."

This method of substitution is similar to that which has already been employed for the transformation of a carbon filament into osmium, for the osmium lamp. Further details are given of the process in the English patent of Just and Hanaman.

"When a carbon filament which is provided with a coating of tungsten of sufficient thickness is submitted in vacuo to an adequate temperature by passing an electric current through it, the carbon combines with the metal surrounding it and a carbide is formed, the whole filament now becoming homogeneous. This process, which may be termed 'dissolving' the carbon, occupies but a few minutes, and takes place the more speedily the greater the excess of metal over carbon. In order to first produce the tungsten coating on the carbon, carbon filaments of the greatest possible fineness (of a diameter of, say, from 0.02 to 0.06 mm. or 0.8 to 2.3 mils) are submitted to the action of an electric current in an atmosphere of tungsten hexachloride in the presence of hydrogen or of some other gas exercising a reducing action, whereby the tungsten is deposited upon the surface of the carbon. When the tungsten coating is of sufficient thickness, the filament is brought to incandescence by an electric current in an atmosphere of a very highly rarefied inert gas, such as hydrogen, at a pressure of 20 millimetres. The solving process, above described, then takes place and is completed in a few minutes. The filament thus obtained contains the carbon in a bound form (mostly as carbide) and presents a glittering white appearance.

"The filament is once more raised to a high temperature by an electric current in a mixture of steam with reducing gases, and the carbon is oxidized by an action similar to that which takes place in the manufacture of water gas."

So far as the lamp itself is concerned, it is stated that the average life of a 110-volt 40 candle power lamp is 1,500 hours, with a consumption of 1 watt per Hefner candle: the illuminating power remaining almost unaltered during the entire life of

the lamp, with little sensitiveness to fluctuations in the supply pressure.

The lamp of Dr. Kuzel has been the subject of much comment in the technical press, this filament being based on two essential features.

"One point is the establishment of the fact that metals in the colloidal condition form plastic masses without the addition of a binding material and can be formed easily into colloidal wires. The second point is that wires formed in this way and dried undergo a physical change when subjected to strong heat; without breaking or disintegrating into powder they pass over from the colloidal state into the crystalline condition and the lamp filament is thereby finished. Dr. Kuzel claims that he can use this method for bringing a great many metals into filament form. In his patent he mentions fourteen, among them tungsten."

Dr. Kuzel is said to favor alloys instead of pure metals, but the details of his method are uncertain. The first admixture of one metal to another acts to lower the melting point, an undesirable result for a lamp filament. It is possible, however, to produce alloys having higher melting points than either of the constituents, and it may be practicable to produce filaments of this kind.

The Welsbach Company is also producing lamps with metallic filaments, including tungsten, and tungsten lamps made by them have been tested and exhibited in Vienna with excellent results. Detailed information is lacking about these lamps, but it is stated that the method of manufacture is to treat the trioxide of tungsten with an excess of ammonia, so as to form a tough paste, and work this into filaments.

The so-called "osram" lamp of the Welsbach Company has a metallic filament made of an alloy of osmium and tungsten, and tests of these lamps by the Reichsanstalt show a consumption of energy of about 1 watt per Hefner candle, with a useful life of 1,000 hours, using alternating current, and these lamps are said to work equally well with the continuous current.

Apparently all the productive researches with tungsten filaments have been made in Austria, but doubtless other investigators are at work, and results may soon be apparent. In any case there appears to be a decided effort to secure some kind of a metallic filament which shall be a satisfactory successor to the thread of carbon.

CORROSION OF CONDENSER TUBES.

THE PRESERVATION OF SURFACE-CONDENSER TUBES IN PLANTS USING SALT OR CONTAMINATED WATER CIRCULATION.

W. W. Churchill—American Association for the Advancement of Science.

ONE of the difficulties encountered in the use of surface condensers, both at sea and in shore power stations where salt or foul circulating water must be used, is the rapid pitting and corrosion of the brass tubes through which the condensing water flows. This subject was very fully discussed in a leading article in this Magazine by Professor A. Humboldt Sexton just one year ago, and now we have a paper presented before the American Association for the Advancement of Science by Mr. W. W. Churchill, detailing the experiences of some of the great electric generating stations in New York City in the same matter.

"The prevention of electrolytic corrosion of condenser parts where they are subject to contact with condensing water that contains electrolytic properties has been a serious problem with condenser engineers at sea as well as on land, where the condensing water contains salts in solution. This action is especially destructive where the cooling water is contaminated further with chemicals or with sewage.

"In the great steam plants of New York City, where the water bills extend into thousands of dollars per annum, in fact are approximately one-tenth of the fuel bills, this is an important condition bearing upon the cost of the hourly power unit, but the attempt to use surface condensers in the past for the purpose of saving this waste has not been accompanied with any degree of success. The highest economy demands such precautions as shall leave the hot-well water coming

from the condensers in a proper condition for feeding the boilers."

The trouble which had been encountered in the corrosion of surface-condenser tubes in existing stations in New York led to a very thorough investigation of the subject in connection with the design of the power house of the Pennsylvania Railroad at Long Island City.

After examining very carefully what had been done elsewhere a series of experimental researches were made, of which Mr. Churchill gives an interesting and instructive account.

"It became evident at once that there was really nothing accurately known about the destructive actions that were taking place in condensers and that a systematic study of the situation for Long Island City was demanded before we should decide on the type of condenser and the wisdom of trying to use hot-well water in the boilers. To that end, we measured the stray currents and found that the voltage of the railroad rails in the terminal freight yard of the Long Island Railroad between the power house and the river was at times as much as nine volts above the potential of the river; that this caused a flow of current to the harbor and a destruction of water pipes and other things in the railroad yards, and that anything that was done would have to be not only able to compensate for this nine volts, but that it must further provide for the control thereof in such a way as to prevent reverse current actions and corrosion of other things. In other words, with the peak of the load on the Brooklyn Rapid Transit system, the voltage would go to nine volts, and as the load sagged off it would decrease, until it was only a volt or two; therefore, whatever was put in must be thoroughly controllable from time to time by switchboard appliances."

A number of combinations of metals were placed in large glass cells, with samples of water taken from the locality, together with comparative cells containing pure water, and a study of these cells showed that the corrosive action of the water from the East River was much more rapid and violent than that of ordinary sea water.

"It soon became evident, by observation of the several combinations in these cells, that there was a violent local action between the zinc and the copper of the brass tubes which were in contact with the electrolyte, and that this increased in the reaction as it progressed in stagnant conditions. It then became necessary to find a method more comprehensive than the proposed simple counter electromotive force for the neutralization of the traction companies' stray currents. Further experiments with plates immersed in the cooling water samples showed that by interposing a counter electromotive force against the galvanic couple which should exceed in pressure the voltage of the galvanic couple, the electrolytic corrosion ceased. The difference in potential between the zinc and the copper for the Long Island City harbor water was found to be 0.4 of a volt. Zinc and copper were selected in these experiments because the condenser tubes were to be made of 60 per cent. copper and 40 per cent. zinc."

In discussing this matter of corrosion Professor Sexton said in the article referred to above, that he was of the opinion that rapid and irregular corrosion, as distinguished from the normal action of sea water, was almost invariably due to electrolytic action, but he believed that this action was due to the contact of particles of substances electro-negative to the brass, probably in most cases carbon. He evidently did not take into account the action of stray currents from external sources, since his researches were confined almost entirely to the conditions obtaining on shipboard.

"It became evident that the influence of various foreign substances in the East River water made the galvanic couple as between an atom of zinc and an atom of copper greater than for open sea water, and it was found to be at times as high as 0.42 of a volt. With this known it was planned to put a potential of 0.6 of a volt on the anode in order to overcome this action and prevent the separation of the zinc molecules from the surface and the consequent breaking down of the tubes.

"In order to accomplish these two things, it was first necessary to install the condensers so as to prevent undue amounts of stray currents flowing through them, thus tending to reduce the amount of power required to prevent injurious action of these

currents and otherwise to neutralize them. This was done by insulating the joints in the piping and from ground connections, and even lining the large water connections with glass melted onto the surface.

"To furnish the required counter electromotive force, a 3-kw. motor-generator set was provided, of the type used for electroplating. By means of a system of wiring, switchboard apparatus and appliances, together with ammeters and voltmeters for measuring currents and pressures, and a connection to an outlying anode in the condensing supply intake at its harbor end, this generator was arranged to provide current to neutralize the stray currents in the condenser structure to any extent that they had passed the insulated joints in the supports and connections as well as through the columns of water in the pipe connections, and then to provide the additional voltage needed to prevent the galvanic action."

Mr. Churchill gives various quotations from Professor Lodge, and from Faraday, to show the reasons for the action as developed in the experiments, and taking the theory as deduced in Faraday's laws of electrolysis, in connection with the results of the present experiments, for the arrangement and proportions of the apparatus very satisfactory results have been obtained.

ELECTRIC MINING HOISTS.

IMPROVED METHODS FOR THE REGULATION AND CONTROL OF ELECTRIC MOTORS FOR THE OPERATION OF DEEP MINE HOISTS.

J. W. H. Hamilton—Engineering and Mining Journal.

AMONG the general applications of electric power in engineering work those relating to mining demand especial attention. Probably no department of power transmission and application offers so many and varied conditions as exist in and about the mine, and for this reason some of the earlier applications encountered practical difficulties which required skill and patience for their solution.

The development of electric machinery for deep mine hoists is an example of the manner in which one of the most troublesome problems in the application of electricity to mining has been solved, and the subject is well treated in a paper by Mr. J. W. H. Hamilton in a recent issue of the *Engineering and Mining Journal.*

In deep shafts, where the amount of power required is large, and the demand irregular, steam has for a long time been considered the only power available. At the start the torque is necessarily very great, especially when the rope is unbalanced. During the period of acceleration the running torque is large until the point of maximum speed is reached, when a comparatively small amount of power is required. Since the engine must be capable of handling the maximum load its mean efficiency must be low, a matter of minor importance in most cases, but the running of such machines demands the highest skill in the operator, the handling of the many levers and valves requiring the closest attention and judgment. It is not surprising, therefore, that the early attempts to introduce electric hoisting machinery should have been of doubtful success, especially when to the special difficulties of hoisting we add the general obstacles encountered in the use of electricity in mines.

"When electric machinery was first used in mining work, the material used for insulation was not of a quality which could withstand the damp atmosphere and the rough usage to which mining machinery in general is subjected. Break-downs on account of defective insulation were frequent, and electrical machinery soon fell into disfavor with mining engineers. Its progress in the mining field has therefore been comparatively slow. Difficulties on account of poor insulation have been overcome in the last few years. There are examples of induction motors which for weeks have been submerged in flooded mines and, after having been thoroughly dried, have been used without any repairing. On account of the improvement in insulation, and for other reasons, electrical mining machinery is returning to favor.

"For small hoists, the series railway motor, on account of its good starting

torque and the almost automatic adjustment of its speed to the load, has shown itself very well adapted. For large hoists, the shunt motor, the speed of which is almost independent of load, is most suitable. If a strong starting torque is required for the large motor, the compound motor will answer the purpose. After the introduction of alternating current machinery and long distance transmission lines, the three-phase induction motor soon secured a place in the mining industry. Because this machine is very simple, and can be relied upon to work well under varying conditions without any attendance, it is admirably fitted for work in a mine. In many mines, three-phase is the only available current, and the induction motor is therefore used for the hoisting machinery. All hoists using this motor, and most of those using the direct current motor, are of the geared type. For direct current motors of over 100 horse power capacity, however, it is advisable to have the motor direct-connected to the hoist, thus doing away with the gear, which always causes more or less loss of power and unnecessarily complicates the machinery."

Direct-current motors have been generally used for mine hoists, the starting and operation being accomplished by means of resistances in series with the motor armatures. A better method is to control the voltage by means of a motor-generator set, the motor of which takes its current from the main bus-bars of the power station.

"The generator armature of the set is connected in series with the armature of the hoist motor, and its voltage at full speed is equal to that of the bus-bars. By changing the field of the generator a complete control of the voltage of the motor terminals can be effected. The hoist motor has its field current supplied directly from the bus-bars. When the voltage of the motor generator is bucking the bus-bar voltage, the armature current for the motor can be reduced to zero. If the field current is decreased, the voltage at the motor terminals rises, and the motors start very smoothly. When the field current has been reduced to zero, the hoist motor has the same voltage as the bus-bars. The field of the generator may now be reversed and the voltage be boosted to twice the bus-bar voltage. If the latter is, for instance, 500 volts, the motor voltage will be 1000 volts; or, in case two motors are connected in series, each will be of 500 volts. A storage battery is not necessary in connection with this system of control, but it is always of advantage. When used, it is connected in parallel to the bus-bars of the station.

"When the power system is located far from the mines, a storage battery cannot be used in the station itself. The cost of transmitting direct current over long distances is prohibitive. A three-phase transmission line is generally used, and the electrical machines are therefore mostly made for alternating current. In case a large mining hoist is to take its power from the same line as the rest of the machinery, it is advisable to install a motor generator set which transforms the alternating current to direct current, as the direct-current motors are much to be preferred to those of alternating current for hoisting purposes. A storage battery can be installed in a substation and connected in parallel to the generator of the motor-generator set. The fluctuations in the load are so well taken up by the battery that a separate transmission line is not necessary for the lighting circuits. In a system of this kind the operation of the hoist does not affect the power factor of the line. As the motor generator stores energy in the battery during intervals between hoisting, the load on the alternating-current motor is maintained almost constant. During the period of acceleration the hoist requires a great deal of power and the energy is taken from both the battery and the motor-generator set. The latter therefore maintains its normal load and its capacity need not be more than half that of the hoist motor."

Instead of employing the storage battery to equalize the load a mechanical method of regulation may be employed, a heavy, high-speed fly-wheel being used. This method, due to Mr. Carl Ilgner, and already successfully employed in numerous hoists in Germany, has many advantages.

"At first glance, it may seem impossible that the fly-wheel should be able to store a sufficient amount of kinetic energy to balance the load on a power system from which one or several large mining hoists take their current. However, a few calculations will show that is is theoretically pos-

sible, and experience has proved that the practical difficulties of the problem can be overcome. The great improvements, which during the last few years have been made in the design of bearings and in the castings of large steel pieces, have made it possible to run heavy fly-wheels at a very high speed. The fly-wheel is mounted on a motor-generator set, which therefore may be termed a fly-wheel converter. This converter runs at a speed which varies just as much as is necessary to make the fly-wheel absorb and discharge the kinetic energy required to balance fluctuations in the load."

Such an arrangement has an elasticity which commends itself to the engineer and to the practical man. The converter may be connected to any system of current distribution which may be desired. The motor of the converter-set maintains an almost uniform load, the power which it transmits in the intervals between the runs of the hoist being taken up by the kinetic energy of the fly-wheel, this enabling the motor to be so proportioned that its efficiency may be a maximum. In practice the fly-wheel is made from 14 to 15 feet in diameter, which, with speeds of 300 to 500 revolutions, may be made to supply enough energy to carry the maximum load of the hoist from the top to the bottom of the shaft. Current diagrams, showing the action of the regulation, give an excellent idea of the manner in which the fly-wheel acts to equalize the load. For changes on the generator load from +2,000 amperes to —1,000 amperes, the load of the motor is kept within very narrow limits. The negative sign indicates that the generator is absorbing energy, running as a motor and returning energy to the fly-wheel; the hoist motor then acting as a generator. The Ward-Leonard system of control is used with this system of hoisting, all the operations of the hoist being controlled by one lever, which is connected with the field rheostat of the generator as well as with the brakes and safety apparatus of the hoist motor.

This plan of employing a fly-wheel as a regulator is but following out the plan used in rolling mills, bolt works, and other places where the fluctuations in the load are large and irregular, but the manner of application to the motor-generator is especially interesting as showing its applicability to electric driving. Such electric hoists are now used in Germany in shafts from 1,000 to 3,000 feet in depth, the current being supplied from various sources, sometimes several miles distant from the winding plant.

SPONTANEOUS COMBUSTION OF COAL.

CAUSES AND METHODS OF PREVENTION OF FIRE FROM THE SPONTANEOUS IGNITION OF LARGE MASSES OF COAL.

Vivian B. Lewes—Society of Arts.

IN the course of a series of valuable lectures upon fire, fire risks and fire prevention delivered before the Society of Arts, Professor Vivian B. Lewes devotes considerable attention to the subject of the spontaneous ignition of coal, a question of such importance to the engineer as to demand notice and review.

Combustion, as is well known, is the phenomenon accompanying the oxidation of various bodies, the energy developed by the combination of the combustible and the oxygen being concentrated into a sufficiently short space of time as to be manifested by perceptible evolution of heat and light. The term "spontaneously inflammable" is generally applied to such substances as have ignition temperatures lower than the ordinary temperature of the air, so that their open combination with oxygen causes them to burst into flame. Other substances, such as phosphorus, have their ignition temperatures so slightly above the air that but a slight increase in warmth is required to cause ignition. Coal, however, does not ignite until a temperature of about 500 degrees C. is reached, so that under ordinary circumstances it does not ignite. If, however, the temperature is raised from any external source of heat, it is altogether probable that ignition may occur, and this is what is meant by the spontaneous ignition of coal.

There are various external sources of heat which may cause the temperature of a mass of coal to rise to the danger point,

and among them Professor Lewes enumerates: physical action, such as the absorption of a large volume of gas and its compression in the pores; or, a direct increase in the temperature of the air; or a direct chemical action, taking place at the ordinary temperature. It must be remembered that the difference in temperature need not be great originally, since one of the conditions of spontaneous ignition of this sort is the absence of opportunity for the heat to escape, the gradual accumulation of heat within a limited space finally causing the temperature to reach the danger point, after which the heat is maintained by the actual process of combustion.

The production of heat by the absorption of a gas is more marked in the case of a porous substance, like charcoal, than with a denser material, and it is partially dependent upon the amount of surface exposed, so that the action is more rapid with finely powdered fuels than in the case of lumps.

"In the spontaneous ignition of coal stored in bulk in gasworks, or being carried in large consignments in vessels to distant ports, we find both absorption of oxygen and increase in temperature playing an important part. There is probably no form of spontaneous ignition that has claimed a heavier tax both in men and money than that of coal, ships engaged in the carriage of this commodity to ports in the Far East having been specially liable to loss from this cause.

"Coal, which is the fossil remains of a monster vegetation that grew long before the earth was inhabited by man, may be looked upon as containing much the same constituents as a lightly-burnt charcoal rendered dense by pressure during its formation, and richer in hydrocarbons, owing to the prevention of the escape of these bodies during its formation. It contains, moreover, not only the inorganic material present in the sap of the original plant, but also mineral matter formed in it by infiltration and reduction during the long ages of its production. It may, therefore, be looked upon as consisting of carbon, hydrocarbons, and inorganic constituents. Amongst these latter we find iron pyrites or disulphide of iron, which occurs sometimes as bright golden laminæ in the cleavage of the coal, sometimes as heavy and metallic lumps where it has formed in a cavity of the coal, and occasionally in a finely-divided and feathery form spread through portions of the coal itself.

"If these pyrites be collected from the coal and made into a large heap exposed to air and moisture, they rapidly heat and often inflame, owing to the oxidising action of the air and moisture upon the sulphur, and it is still believed by many observers that it is this action in the coal itself which gives rise to its spontaneous ignition."

Professor Lewes does not believe that the oxidation of pyrites plays a very important part in the ignition of masses of coal, since spontaneous ignition is frequently known to occur in coals which contain little or no sulphur. The rise in temperature is mainly due to the absorption of oxygen by the freshly-won coal and the activity of the gas in contact with the hydrocarbons.

"In the coal seam the pores of the coal are filled with methane, or a mixture of methane and carbon dioxide, gases produced during the actions that led to the formation of the coal. When this coal is won and brought to the surface the coal exudes these gases from its surface, and in turn absorbs oxygen from the air. The action, however, cannot go on to any great depth in the coal, and while the pieces are fairly large no heat shows itself, but as the coal gets more and more broken by jolting during carriage and shooting into the ship's hold, the surface becomes enormously increased, and the mass of fine coal formed under the tip and below the hatchways in the ship is generally the spot at which heating and eventually ignition develops.

"The mere absorption of the oxygen, however, is insufficient to bring about serious consequences unless there be an initial rise in temperature to start the action, and in coal-cargo ships it is found in the enhanced air temperature in the tropics, in the ship's bunkers by contact with the casings near the boilers, and in coal stores on shore by proximity to a steam pipe or flue. In every case it was found that the spontaneous ignition of the coal started at the point where the cause of the initial

rise of the temperature was to be found."

Since it is the accumulation of heat which causes the temperature finally to attain the ignition point, it is natural to endeavor to prevent spontaneous combustion by providing a free ventilation, so that the heat may be carried off and the mass kept down to atmospheric temperature. This, however, is very difficult of accomplishment, since it is practically impossible to insure a free circulation through the interior of the mass, and the result of any such attempt is only a more rapid oxidation and increased danger.

"Moisture is a very powerful agent in aiding chemical action, and, as is well known, many forms of combination, such as the burning of carbon monoxide in oxygen, and even the combination of phosphorus with oxygen are prevented if both the reacting substances are perfectly dry. In the same way the action of the occluded oxygen in the coal is enormously aided by the presence of moisture, so that heavy rain whilst a coal cargo is being taken on board, or being stored, generally results in heating, and often in active danger.

"In coal stores on land the action of weathering is perfectly well recognised, and it is well known by the gas manager that in coal which has been stored for a long period loss in hydrocarbons takes place, which shows itself in either diminished volume or decreased luminosity in the gas produced from long-exposed coal.

"In this case, as in all others, mass plays a very important part, as may be seen from statistics with regard to cases of ignition of coal cargoes shipped to Eastern ports. With 500 tons of coal to the cargo the cases of spontaneous combustion amount to only ¼ per cent, whilst, when the bulk is increased to 2,000 tons, the number of cases of spontaneous combustion rises to 9 per cent.

"In order to prevent the spontaneous ignition of large masses of coal, the most important precaution to take is to prevent as far as possible breakage during storing, as the exposure of fresh surfaces of coal just at the time when it is being put under conditions in which the heat generated by the action of the oxygen cannot escape, is one of the chief factors that generally leads to the danger. The breaking up of the coal which has taken place in the earlier stages of its career has probably had time to complete this action and get rid of the heat to the air, whilst in the store itself the greatest care must be exercised in order that no flue, drain, or steam pipe that can give rise to an increase in temperature is anywhere near the store."

In the case of the occurrence of fires in coal masses, especially on shipboard, the ordinary methods of fire fighting are practically inadmissible. The incandescent portion is near the bottom of the mass, and any attempt to pump water in and let it find its way to the seat of combustion is impracticable. Before the water can filter its way through the coal it has to pass through heated portions, and when it reaches the red-hot mass it is partly converted into water gas, requiring only a small proportion of air to become a very explosive mixture. Steam is hardly better than water, the gas being produced in a similar manner, while the cooling action is less than that which the water might have.

Attempts have been made to use sulphur dioxide, produced by burning sulphur, and this does give an extinctive action, but lacks the cooling property so essential to the permanent control of the fire.

Carbon dioxide appears to be the ideal substance to use in the extinction of spontaneous coal fires, but it is difficult of employment in the gaseous state. The commercial production of liquid carbon dioxide, condensed in steel cylinders, has led Professor Lewes to suggest the placing of such cylinders in the midst of the mass of coal on shipboard, providing the flasks with fusible plugs which would melt and allow the escape of the gas before the dangerous ignition temperature was reached. The intense cold produced by the evaporating liquid would act to lower the temperature, while the gas, being generated directly at the hottest points, would extinguish any fire which may have started. There are some practical difficulties with this method which may retard its introduction, but it appears to be altogether capable of insuring freedom from danger, and it should lead to some definite system of protection against what is now a very serious danger.

THE ROLLING OF SHIPS.

THE PRACTICABILITY OF USING THE GYROSCOPIC ACTION OF A ROTATING FLY-WHEEL TO PREVENT THE ROLLING OF A VESSEL.

Otto Schlick—Verein Deutscher Ingenieure.

WITH the numerous improvements which are continually being made in the operation of steamships the comfort of the passengers is being more and more considered. In fact, the question of speed, on many transatlantic lines, has become secondary to that of minimizing the discomforts formerly considered inseparable from an ocean voyage, and experience has shown that these considerations have much influence in directing and controlling profitable business.

Since much of the discomfort felt by sensitive passengers is due to vibratory and other movements of the vessel much ingenuity has been expended to remove these sources of trouble. One of the greatest advantages claimed for the steam turbine in marine service is its freedom from vibration, while to meet the same point the method of steadying the four-cylinder reciprocating engine by arranging the crank angles at the most favorable points for balancing has been brought to a high degree of perfection.

The engineer who has given much successful attention to the balancing of reciprocating marine engines, Herr Otto Schlick, of Hamburg, has more recently devoted his efforts to the question of minimizing the rolling movements of the hull of a vessel, or rather to the prevention of the lateral oscillations produced by the action of the sea. For this purpose he has examined into the practicability of utilizing the principle of the gyroscope, employing the resistance which a rapidly rotating fly-wheel opposes to any change in the plane of rotation to the purpose of checking the movement of the hull of the vessel. The results of these investigations have been presented by him in a paper read befor the Hamburg branch of the *Verein Deutscher Ingenieure*, and published in a recent issue of the *Zeitschrift* of the society, from which we make some abstracts.

According to the well-known principles of the gyroscope, a rotating wheel with a heavy rim, following the laws of inertia, tends to resist any external force which may act to change its plane of rotation. This action has already been employed in connection with the control of submarine torpedoes, and Herr Schlick shows how such a rotating wheel tends to oppose any force acting to disturb its plane of rotation, or having displaced it, to oppose any return to the former position, thus acting to maintain the position in opposition to any external forces. Such an action appears to have existed already in the case of paddle-wheel steamships, although the low rotative speeds of the wheels has prevented the effect from being very apparent The arrangement proposed by Herr Schlick is that of a wheel mounted on a vertical axis, this shaft being held in a strong frame supported on transverse trunnions, the wheel being given its rotation by means of an electric motor.

This arrangement, however, does not act to damp the rolling oscillations of the ship, but rather to introduce an action which may be compounded with the rolling. The most practical method of utilizing the resistance of the gyroscope wheel is to introduce some form of retarder, such as a friction brake, or hydraulic check cylinder, between the hull of the ship and the frame which carries the fly-wheel.

The rolling of the ship is similar to that of a pendulum, the period depending upon the distance between the metacentre and the centre of gravity. The gyroscope wheel then opposes a resistance to the oscillation, which partially yields to the effort of the ship, the movement being largely absorbed by the brake, this latter acting to convert the energy into heat, which is dissipated into the atmosphere. This, then, is the true method of minimizing the rolling action of a ship, by interposing some form of energy absorber between the hull and the opposing abutment, this latter being furnished by the resistance offered by the gyroscope wheel to any disturbance tending to change its

plane of rotation. The wheel opposes equally any movement of the hull from the level position or back to that position, and if it were rigidly secured to the hull the desired end would not be attained, but by the introduction of a dashpot action, or its equivalent brake, there exists at all times a damping action upon the oscillations which is most effective.

Herr Schlick computes that for a vessel of 6,000 tons displacement, with a metacentric height of 1.2 metres, and a rolling period of 10 seconds, a fly-wheel 5 metres in diameter and 10 tons weight would be sufficient to neutralize practically the entire rolling action. A metacentric height of 1.2 metres is unusually great, and if we take this height as equal to 0.6 metre, which is quite within the limits of proportion for such a vessel, the dimensions of the wheel will be materially reduced, a diameter of 4 metres, for the same weight, being sufficient.

The forces involved in the rolling of a ship are by no means so great as is generally supposed. It is well known that 20 to 25 men moving in unison from one side to the other, can set a large vessel into marked oscillations. In a similar manner a rolling vessel may be brought to rest, by moving in opposition to the direction of the oscillations. This fact is also proved by the effective manner in which the so-called bilge keels act to check rolling, although it is apparent that they offer but a slight resistance to movement in the water.

The desirability of reducing the rolling movement of a vessel cannot be denied, but it is possible that too much may be expected of it so far as the prevention of seasickness is concerned. Many years ago the late Sir Henry Bessemer expended a large sum of money in the design and construction of a vessel for service on the English Channel, the plan including a saloon suspended upon gimbals in a manner similar to the suspension used for a ship's compass. Such a construction insured the maintenance of a level position, regardless of the movements of the hull, but absence from sickness did not follow. Apparently the vertical movement alone is sufficient to disturb many passengers, as is witnessed by the sinking sensation experienced in a rapidly descending elevator, so that mere freedom from rolling is not sufficient. It is probably, however, that any practicable device which prevents rolling will be found most valuable in providing a steady gun platform for war-ships, and it is in this department of marine engineering that the gyroscope may find its most useful application.

ERRORS IN MEASUREMENT.

STANDARDISATION OF BRITISH SHOP PRACTICE IN CYLINDRICAL MACHINE WORK AND THE DETERMINATION OF LIMIT GAUGES.

Report of the Engineering Standards Committee.

WE have referred elsewhere in these reviews to the origin and work of the Engineering Standards Committee, and among the recent reports issued by this body are two which demand especial attention at the present time. The first of these is the report on errors in workmanship, and practically consists of a classified mass of data gathered from the leading machine shops of Great Britain, limited to measurements obtained from plain cylindrical work selected from locomotives, gun mountings, gas engines, dynamos, high-speed engines, and machine tools. A study of the tolerances and allowances thus gathered from actual practice has enabled the preparation of the second report, giving a standard system for limit gauges for running fits. The two reports thus give a record of what is conceded, by high authority, to be the best representative British engineering practice in this important element of machine work; and a scientific analysis of that practice, reducing it to such form as to render the best work possible in every shop with a minimum of expense or uncertainty.

The pieces of work upon which the measurements were made were selected from regular product of the various establishments, but the measurements were made under the supervision of the National Physical Laboratory, the caliper micro-

meters being compared from time to time with the standard length piece most nearly approaching the diameter of the shaft measured, the limit of accuracy being stated to be about 0.0005 inch; variations of temperature, and the presence of foreign matter preventing a higher degree of precision.

In discussing the results it is important to maintain a clear understanding of the meanings of the terms employed, and the definitions used by the committee are, in any case, desirable for use at all times when speaking of these and allied subjects. Thus: *Tolerance* is defined to mean a difference in dimensions, prescribed in order to tolerate unavoidable imperfections of workmanship; *Allowance* is a difference in dimensions, prescribed in order to allow of various qualities of fit; and *Clearance*, is a difference in dimensions or in shape of surface, prescribed in order that two surfaces or parts of surfaces, may be clear of one another.

The various firms whose work was examined adopted different methods of practice, but even those who were not employing any system of limits recognised the necessity for allowances, and gave their values. The distribution of these allowances also varied. Thus, in some cases the allowance was made in the hole, in others on the shaft, and in still others it was divided. The results are tabulated very fully in the first report, these tables classifying the work according as to whether it was originally manufactured to limits or not, and also separating ground work from pieces not ground. The relative order of excellence of the different classes of work is shown in a special table, the highest degree of accuracy appearing in high-speed engines and dynamos, and the lowest in large machine tools. The value of the different methods of working is clearly shown, the ground shafts being much truer and closer to size than those not ground.

The tables in the first report give the results for running and for sliding fits, as well as for forcing fits, but at the present time the subject of standard limit gauges has been settled only for running fits, although the tables give useful information as to the practice of leading firms in the other departments of work.

Limit gauges, as is well understood, are intended to ensure that any given dimension is within the tolerance laid down for the particular class of work to be produced. According to the report of the committee three classes of such gauges are considered; standard limit gauges, made with the greatest possible accuracy, and deposited with the National Physical Laboratory for purposes of reference; reference limit gauges, or copies of the standard gauges, to be used as standards of reference in the workshop; and shop limit gauges, being those actually used in the shop, and checked against the reference limit gauges.

Recognising the fact that different kinds of work demand various degrees of accuracy, three classes of workmanship are provided for, covering sizes from ¼ inch to 12 inches in diameter, and to these there is appended a special class for extra fine work, this being only for sizes up to three inches.

After a careful study of the practice of the various shops, and the conditions of workmanship, the committee recommends that, wherever possible, the shaft should be the element more nearly approaching the true dimension, and the allowance made on the hole. A minimum allowance is specified between the two elements, and above this a positive tolerance given for the hole. This conclusion is doubtless influenced by the fact that, in many instances a number of pieces have to be fitted to one and the same shaft, so that the shaft itself becomes the piece to which the other parts have to be fitted. Tolerances are given, however, for work in which it is found necessary to adopt the "hole basis," so that the requirements of all classes of work are provided for.

Standardisation work of this sort is most desirable, and the Engineering Standards Committee is to be congratulated both upon the thoroughness with which the investigation has been carried out and the full manner in which the sources and methods have been made public. The published system for limit gauges for standard running fits appears to be altogether complete and satisfactory, and the satisfaction with which it will doubtless be received, will be partly due to the fact that it is avowedly based upon the actual practice of high-class machine shops, and thus properly adapted to the immediate work of the day.

SUCTION GAS POWER.

THE SUCCESSFUL USE OF THE SUCTION GAS PRODUCER AND ENGINE IN THE GENERATION OF ELECTRICITY.

W. Schirmacher—Elektrotechnische Zeitschrift.

ALTHOUGH the suction gas producer is now well established as an effective highly economical source of fuel for the gas engine, its use has been mainly limited to small powers and isolated purposes, services for which its simplicity and convenience render it well adapted. There is no reason, however, why this excellent form of power-generating plant should not be applied to larger powers, and hence the account of the installation of gas engines and producers in the municipal electric station at Schwerin, in Mecklenberg, as given by Director Schirmacher, in the *Elektrotechnische Zeitschrift*, is of interest.

At the present time there are installed at Schwerin two gas engines of 300 horse power, with their corresponding suction producers, the buildings and general arrangement permitting the addition of other units when desired. Each engine has its own producer, scrubber, and purifier, as is necessitated by the principle of the system, but this also renders each unit independent of the other, a principle now accepted as desirable in any type of motive power plant.

The general arrangement of the plant calls for no especial comment, but at the same time there are certain details which have appeared in practice which are of value in connection with the installation of such a system in the midst of a city. Thus, the starting of the producer, by using a fan blower, delivering air through the deep bed of coal, is ordinarily accompanied with an objectionable discharge of gas and sulphurous vapor. This is avoided by arranging a temporary igniting burner, using city gas, so as to light the first products after they have passed through the vaporiser, and before the engine is started. As soon as the fuel bed in the generator has become sufficiently ignited to permit the starting of the engine, this gas jet is shut off, the blower stopped, and thereafter the air and vapor of water are drawn through the producer by the suction of the engine, the entire products passing through the engine as usual.

When the plant was first started much trouble was experienced by the noise of the exhaust from the gas engines, this causing disturbance to the neighboring residents. Experiments with various forms of exhaust silencers, water spray, etc., failed to abate the trouble, but finally the sound was suppressed by the use of a large underground discharge chamber, 11 metres long by 3 metres wide and high. The engines discharged their exhaust into this chamber horizontally, while a vertical exhaust pipe rose from the chamber into the air, the exhaust gases passing into this vertical pipe through a number of holes. This arrangement appears to have acted as an effectual noise damper, thus abating the nuisance.

The gas engines at the Schwerin station are of the horizontal Körting two-cycle type, with water-cooled pistons. Each engine develops 300 horse power at 125 revolutions per minute, and the fuel consumption shows about 0.7 kilogramme per kilowatt-hour, or 1.15 pounds per horse-power-hour. The fuel used in the producer is either anthracite, or furnace or gas coke.

Apart from the fuel economy, an important element in such an installation is the small amount of labor involved. Thus, this plant employs only three men, one being a skilled engineer, one a switchboard man, and one a fireman, the latter also acting as cleaner, and having ample time to attend the heating plant of the building in winter. It is this simplicity in operation and attendance and care which forms one of the strongest points about the suction gas power system, and the fact that it can thus be applied directly to electric stations in fairly large units with as much success as has attended its use in small installations should be a strong factor in its extension. The growing interest in gas power for many purposes, and the perfection which is being attained in the design and construction of large gas engines should cause the designing and electrical engineer to turn his attention closely to this source of power, and not repeat the error of the earlier days.

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The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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A Four-Span Reinforced-Concrete Arch Bridge on the Southern Railway. H. C. Harrison. The construction of a railroad bridge near Austell, Georgia, is illustrated and described. 4000 w. Eng Rec Sept. 22, 1906. No. 79428.

A Single-Track Reinforced-Concrete Electric Railway Bridge Near Belvidere, Ill. Illstrates and describes the construction of a novel bridge, 350 ft. long, comprising four arches of 81 ft. clear span each. 3000 w. St Ry Jour—Sept. 1, 1906. No. 78922 C.

Strauss Ribbed Concrete-Steel Bridge for the Elgin-Belvidere Electric Railroad. Illustrated detailed description of a four-arch bridge near Belvidere, Ill. The concrete arches were cast in suspended forms, without centerings. 3000 w. R R Gaz—Sept. 14, 1906. No. 79192.

Bascule.

Bascule Bridges. An illustrated arti-

We supply copies of these articles. See page 319.

cle describing early and recent types. 2500 w. Ry & Loc Engng—Sept., 1906. No. 78955 C.

Falsework.

Steel Falsework Used in the Erection of the Quebec Bridge. Illustrated description of the falsework with information concerning the erection. 1800 w. Eng Rec—Sept. 8, 1906. No. 79030.

High-Level.

Four-Track Deck Bridge Over the Tyne at Newcastle, England. Illustrates a new high-level bridge with brief description of its design and construction. 1100 w. Eng News—Sept. 6, 1906. No. 79088.

Loads.

Equivalent Uniform Live Loads for Railroad Bridge Trusses. J. E. Kirkham. Gives a method for determining uniform loads equivalent to the typical wheel loads specified by the railroads. 1000 w. Eng News—Sept. 13, 1906. No. 79171.

Maximum Bridge Stresses Under Live Load. R. M. Packard. An explanation of the standards for maximum bending moment and shear under moving loads, and the circumstances under which they are satisfied. 1500 w. Eng Rec—Sept. 8, 1906. No. 79039.

Moving Loads on Railway Under-Bridges. H. Bamford. Graphical determination of the maximum bending moment and maximum shear due to a train-load. 2200 w. Engng—Sept. 7, 1906. Serial. 1st part. No. 79232 A.

New York.

Progress in the Blackwell's Island Bridge. An illustrated description of the erection of the superstructure for the island span of this bridge across the East River at New York City. 3000 w. Eng Rec—Sept. 15, 1906. No. 79157.

Plate Girders.

The Design of Plate Girders. Presents a rational order of procedure in designing such bridges, discussing details. 3000 w. Engr, Lond—Aug. 24, 1906. No. 79016 A.

Portland, Ore.

The New Morrison Street Bridge, Portland, Oregon. H. A. Crafts. Illustrated detailed description of the construction of a large bridge with a 384-foot draw span. The work had to be carried on without interruption of the heavy traffic or of navigation. 800 w. Sci Am Sup—Sept. 22, 1906. No. 79289.

Quebec.

Camber Adjustments Made in the Erection of the Quebec Bridge. Illustrates and describes unusual construction to meet severe requirements. 800 w. Eng Rec—Sept. 15, 1906. No. 79161.

The Erection of the Quebec Bridge. Illustrates and describes interesting features in this highway and railroad bridge across the St. Lawrence River—the longest span bridge ever built. 1300 w. Sci Am—Sept. 29, 1906. No. 79499.

Raising.

Raising of Canal Bridge at Schenectady, New York. Illustrates and describes the methods used in raising a modified Pratt, through riveted truss bridge of 162-ft. span, built on a skew of 35 degrees, and carrying four tracks. 1800 w. R R Gaz—Sept. 21, 1906. No. 79403.

Reinforced Concrete.

See Civil Engineering, Construction.

Removal.

The Removal of the Passy Bridge (Déplacement de la Passerelle de Passy). L. Biette. Describing the manner in which a bridge across the Seine at Paris was shifted bodily 29 metres from its original position. 5000 w. 2 plates. Am d Ponts et Chaussées—2 Trimestre, 1906. No. 79332 E+F.

Steel Bridges.

Bridges for Electric Railways. C. C. Schneider. Considers only steel structures, illustrating a variety of types. 4500 w. St Ry Jour—Sept. 15, 1906. Serial. 1st part. No. 79201 C.

Suspension.

Longitudinal Displacement of the Suspended Structure of the Williamsburgh Bridge, at New York, N. Y. A statement and explanation of the displacement, and the remedy. 1200 w. Eng News—Sept. 20, 1906. No. 79288.

Swing Bridges.

A Heavy Center-Bearing Draw Span. The 270-ft. swing span of the bridge over the Harlem Ship Canal at Kingsbridge, N. Y., is illustrated and described. Its total weight is 3,000,000 pounds. 1000 w. Eng Rec—Sept. 1, 1906. No. 78929.

The Swing Bridge over the North-Sea Canal at Velsen, Holland (Pont Tournant sur le Canal de la Mer du Nord à Velsen) with a photograph of the completed bridge and details of the electric control of the large swing span. 2000 w. 1 plate. Génie Civil—Sept. 1, 1906. No. 79321 D.

Transporter.

Newport Transporter Bridge. Illustrates and describes this recently completed bridge in England, over the river Usk. 3000 w. Tram & Ry Wld—Sept. 6, 1906. No. 79297 B.

The Transporter Bridge at Newport. An illustrated detailed description of the recently completed bridge across the Usk River in England, with information of related interest. 4000 w. Engr, Lond—Sept. 14, 1906. No. 79453 A.

Viaduct.

An Eight-Track Reinforced-Concrete

We supply copies of these articles. See page 319.

Viaduct in Winnipeg, Manitoba. Illustrates and describes a structure on the Canadian Pacific R. R. of interest on account of the special design of the concrete groined arches in it and from the character of the reinforcement. 1200 w. Eng Rec—Sept. 15, 1906. No. 79159.

The Caneadea Viaduct of the Buffalo & Susquehanna Ry. Joseph Mayer. Illustrated detailed description of a high steel viaduct 754 ft. long. 1500 w. Eng News—Sept. 13, 1906. No. 79165.

CONSTRUCTION.

Beams.

The Computation of Supporting Beams (Beitrag zur Berechnung von Unterzügen). Prof. G. Ramisch. A mathematical study of the distribution of forces in the case of an auxiliary supporting beam beneath several cross beams; with examples for various loadings. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 17, 1906. No. 79327 D.

Caissons.

Restoring to the Perpendicular a Compressed Air Caisson. Describes an accident, in Belgium, in getting in the foundations of the central pivot pier of a swing span, in sinking of the caisson, and the manner of overcoming the difficulty. Ills. 1000 w. Engr, Lond—Aug. 24, 1906. No. 79014 A.

Chimneys.

Tall Chimney Construction. J. E. Stafford. Detailed particulars and drawings of a tall chimney erected at Clitheroe, Lancashire. 1800 w. Builder—Sept. 8, 1906. No. 79213 A.

Foundations.

Comparative Designs of Steel and Reinforced Concrete for Cantilever Foundation Girders. Illustrates and describes the preliminary design for steel cantilever girders and grillage, and the accepted plan of reinforced-concrete footings and girders. 700 w. Eng Rec—Sept. 1, 1906. No. 78926.

House Wrecking.

The Business of House-Wrecking. George Ethelbert Walsh. Describes the systematic work of the large wrecking companies. 2500 w. Archts & Builds' Mag—Sept., 1906. No. 79188 C.

Office Building.

An Eighteen-Story Steel-Cage Building. Illustrated description of a building under construction at the corner of Wall St. and Broadway, New York City. 1600 w. Eng Rec—Sept. 22, 1906. No. 79432.

Piers.

A Novel Method of Cylinder Pier Reinforcement. Illustrated description of a novel method of strengthening old cylinder piers, used on a bridge at Clarendon, Ark. 700 w. R R Gaz—Aug. 31, 1906. No. 78965.

Piles.

Cost of Making and Placing Reinforced Concrete Piles at Atlantic City, N. J. Gives a summary of the cost of the reinforced concrete trestle of two-pile bents used in widening the promenade sections of the pier. Ills. 400 w. Eng News—Sept. 6, 1906. No. 79095.

The Use of Concrete Piles. Translated from *Le Génie Civil.* Illustrated descriptions of various types of concrete piles and their construction. 1800 w. R R Gaz—Sept. 21, 1906. No. 79402.

Reinforced Concrete.

A Knotty Problem in Stress-Analysis; Dangerous "Safe Stresses" in a Reinforced Concrete Bridge. Gives letters from Daniel B. Luten concerning a bridge that failed, with report on the failure. Ills. 2800 w. Eng News—Sept. 27, 1906. No. 79474.

A Rapid General Method for the Calculation of Reinforced Concrete Sections. Richard T. Dana. Presents formulas and diagrams which the writer believes will result in a considerable saving of time. 2700 w. Eng Rec—Sept. 1, 1906. No. 78931.

Cost Reduction of Reinforced Concrete Work. E. P. Goodrich. Extracts from a paper before the Am. Soc. of Port. Cement Mfrs. A discussion of the ways in which economy can be secured. 5000 w. Munic Engng—Sept., 1906. No. 79271 C.

Failure of a Reinforced Concrete Building. A report of the failure of a factory at Elyria, Ohio, while in process of construction. Ills. 1000 w. Ir Trd Rev—Sept. 13, 1906. No. 79180.

Hard and Mild Steel in Reinforced Concrete. Discusses these materials, concluding that it really matters little which is used. 2000 w. Engng—Aug. 24, 1906. No. 79012 A.

Reinforced Concrete in the San Francisco Fire. Editorial review of the recently published book on the San Francisco fire and its lessons, by A. L. A. Himmelwright, which is being much discussed. 3000 w. Eng News—Sept. 27, 1906. No. 79473.

Tests of the Effect of Heat on Reinforced Concrete Columns. H. B. MacFarland. An illustrated article giving details of some interesting experiments recently made at the Chicago Laboratory of the National Fireproofing Co. Ills. 2000 w. Eng News—Sept. 20, 1906. No. 79287.

The Progress and Logical Design of Reinforced Concrete. Ross F. Tucker. Reviews the progress of this material since 1885, giving suggestions for economical designs, and discussing its durability. Ills. 2000 w. Cement Age—Sept., 1906. No. 79259.

See also Civil Engineering, Bridges.

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Roads.

The Construction and Maintenance of Rural Roads. Part of a paper by Robert Phillips read before the Roy. San. Inst. Describes Macadam's and Telford's methods of construction, and discusses maintenance. 2000 w. Builder—Sept. 1, 1906. No. 79107 A.

Safety.

Factors of Safety. Editorial, giving an analysis of the elements of factors of safety, discussing the material, the structure or composition, and the loads or attack in service, and other influences. 2800 w. Eng News—Sept. 6, 1906. No. 79097.

Tall Buildings.

A 40-Story Building in New York City. Illustrates and describes changes to be made in the Singer buildings, corner of Liberty St. and Broadway, New York City. 2000 w. Eng Rec—Sept. 8, 1906. No. 79032.

An Office Building 612 Feet Tall—The Loftiest Masonry Structure in the World. Illustrations of the Singer tower to be built in New York City, with description. 1200 w. Sci Am—Sept. 8, 1906. No. 79079.

Tunnels.

Boring Machines in the Bosruck Tunnel (Die Maschinelle Bohrung im Bosrucktunnel). Rudolf Heine. An illustrated description of the conduct of the work on the Bosruck tunnel on the Pyhrn railway in the Tyrol; with details of the Gatti rock drills, as well as the electric power machinery. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 1, 1906. No. 79370 D.

Lowering the Tunnels Under the Chicago River. Briefly outlines the history of these tunnels and their construction, and gives an illustrated description of the methods of lowering them. 3500 w. Eng News—Sept. 13, 1906. No. 79169.

The Detroit River Tunnel of the Michigan Central. Gives details of the modified plan adopted. 1500 w. Ry Age —Sept. 7, 1906. No. 79072.

The Scheme for a Tunnel under the English Channel (Le Projet de Tunnel sous la Manche). With plan and profile, discussing the difficulties of the work in the light of modern experience. 2000 w. Génie Civil—Sept. 8, 1906. No. 79324 D.

See also Railway Engineering, Permanent Way.

Waterproofing.

Waterproofing Concrete on U. S. Fortification Work. Emile Low. Abstracts from Technical Details of Engineering Methods on Fortifications, Rivers and Harbors, and other works. 2500 w. Eng News—Sept. 6, 1906. No. 79096.

MATERIALS OF CONSTRUCTION.

Bitumen.

The Bitumen Springs of Antiquity. Edgar James Banks. An interesting account of the bitumen springs on the Euphrates, and the uses made of the material. 1200 w. Eng News—Sept. 6, 1906. No. 79094.

Building Materials.

Building Materials in the San Francisco Earthquake. Information taken from a series of articles by Wm. Ham. Hall for the *San Francisco Chronicle*, in regard to the reasons for the great differences in the effects of the earthquake upon buildings and streets. 3500 w. Munic Engng—Sept., 1906. No. 79269 C.

Cement.

Notes on Compression Tests of Cement. W. Purves Taylor. Read before the Am. Soc. of Test Mat. A report of tests carried out in the Philadelphia laboratories. 1200 w. Cement Age—Sept., 1906. No. 79258.

Clay.

The Use of Burned Clay Products in the Fireproofing of Buildings. Peter B. Wight. Read before the Int. Cong. of Archts., London. Treats of the actual use of burned clay in building construction as employed in the United States in the erection of fireproof buildings. 3000 w. Am Archt—Sept. 1, 1906. Serial. 1st part. No. 78909.

Gypsum.

Gypsum Plants, or the Manufacture of Plaster of Paris, or Stucco. C. O. Bartlett. Describes the machinery used in the manufacture of plaster-of-Paris. 700 w. Min Rept—Sept. 20, 1906. No. 79420.

Industrial Applications of Gypsum. Robert Grimshaw. The use of gypsum for casts and the methods of molding are discussed in the present article, also its use as a cement, and in interior decorations and construction. 2700 w. Sci Am Sup—Sept. 29, 1906. Serial. 1st part. No. 79504.

Reinforced Concrete.

See Civil Engineering, Construction.

Slag.

Slag Granulating and Conveying Device. Hiram W. Hixon. Drawing and description of a device which has been in use five years. 700 w. Eng & Min Jour—Sept. 22, 1906. No. 79414.

Stone.

Note on the Resistance of Building Stones to Frost. Prof. J. Malette. Brief description of methods of testing building stones, with illustrations of blocks treated. 1000 w. Builder—Sept. 15, 1906. No. 79438 A.

Terra Cotta.

New Uses for Terra Cotta Building Blocks. An illustrated description of

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various types of blocks and their uses. 2000 w. Br Build—Aug., 1906. No. 79150 D.

Timber.

The Timber Creosoting Plant at Shirley, Ind. H. H. Knowlton. Abstract of a paper read before the Indiana Engng. Soc. Describes a plant employing the Rueping process, which injects creosote oil under pressure. 3000 w. Eng News—Sept. 13, 1906. No. 79166.

MEASUREMENT.

Force-Diagrams.

The Drawing of Force-Diagrams for Framed Structures. Archibald Sharp. Calls attention to a well-known geometrical relation between a frame diagram and the corresponding force diagram, of great utility in the actual drawing of the force diagram. 1000 w. Engng—Aug. 31, 1906. No. 79135 A.

Surveying.

Final Results of the Simplon Tunnel Survey. Prof. Dr. M. Rosenmund, in *Schweizerische Bauzeitung*. 2600 w. Bul Int Ry Cong—Aug., 1906. No. 79282 E.

Measurement of Base Lines. A brief review of old and new methods, the improvements and related advancement. 1800 w. Engr, Lond—Aug. 31, 1906. No. 79146 A.

MUNICIPAL.

Boulevard.

Recent Work on the Extension of Riverside Drive. Illustrates and describes recent work above 135th Street, on this beautiful boulevard at New York City. 2500 w. Eng Rec—Sept. 15, 1906. No. 79160.

Galveston.

The Relocation of Public Service Systems During the Grade Raising of Galveston, Tex. An illustrated article explaining how some of the problems arising from raising the grade of the lower part of the city were solved. The relocation of gas and water pipes, sewers, street railway tracks, etc. 4000 w. Eng Rec—Sept. 15, 1906. No. 79162.

Harbor Pollution.

The Pollution of Tidal Waters of New York City and Vicinity. George A. Soper. A study of the proposal to empty sewage from New Jersey into New York Bay without purification. Discusses the problem from a sanitary standpoint. Also general discussion. 12600 w. Jour Assn of Engng Socs—June, 1906. No. 79268 C.

Improvements.

New Paving and Sewerage Work at Fort Smith, Ark. George Myers. Outlines extensive improvements to be carried out in a small city. 500 w. Eng News—Sept. 6, 1906. No. 79090.

Municipal Transit.

A Suggested Solution of Metropolitan Transit. W. Jones Cuthbertson. States the objections to the systems now in use and discusses a system having the railroad on the surface and the common road above it, describing details. Ills. 5500 w Jour Assn of Engng Socs—June, 1906. No. 79267 C.

Refuse.

Disposal of Dye and Wool Finishing Waste. Herman Stabler. From a report to the Ohio State Board of Health. An investigation of the effluent of the Cleveland Worsted Mills Co., located at Ravenna, Ohio. 4500 w. Munic Engng—Sept., 1906. No. 79270 C.

Refuse Destructor Plant for the City of Brünn, Austria (Die Müllverbrennungs Anlage der Stadtgemeinde Brunn). Sigmund Kander. Illustrating the arrangement of the cremator furnaces, and steam plant, and diagrams showing operation. Two articles. 5000 w. Elektrotech u Maschinenbau—Sept. 9, 16, 1906. No. 79364, each D.

The Disposal of House Refuse (Die Beseitigung von Hausmüll). Dr. Klemens Dörr. Giving physical and chemical analyses of the refuse of various German cities, and discussing the practicability of its use as fuel. Three articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 17, 24, 31, 1906. No. 79325, each D.

Roads.

Road Tarring in France. Illustrates and describes methods and appliances used for this work. 1200 w. Sci Am—Sept. 15, 1906. No. 79174.

Sewage.

Design of Works for Bacterial Treatment of Sewage. From a paper by J. S. Pickering read before the British Congress of the Roy. San. Inst. Describes the works of purification. 2400 w. Builder—Sept. 1, 1906. No. 79106 A.

Report of a London Engineer on Sewage Disposal at Toronto, Ont. Reviews the report on the Toronto sewage problem made by G. R. Strachan. 2000 w. Eng News—Sept. 6, 1906. No. 79098.

Sewage Purification Works and the Health of the Community. J. Ashton. Part of a paper read before the Inst. of San. Engrs. Reviews the progress in England relating to sewage purification and river pollution. 2200 w. Builder—Sept. 1, 1906. No. 79108 A.

Sludge Treatment in Relation to Sewage Disposal. John D. Watson. Read at meeting of the Assn. of Munic. & Co. Engrs. Also editorial. A valuable report of results at Birmingham, England. Deals with the arresting and disposal of the solids, and the precipitating of organic sludge and converting it into

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an inodorous substance. 6000 w. Eng Rec—Sept. 1, 1906. No. 78930.

WATER SUPPLY.

Algae.

The Prevention of the Growth of Algae in Water Supplies. Abstract of a paper by Samuel Rideal and Ronald Orchard presented at meeting of the Royal Sanitary Inst. Reviews the methods of treatment which have proved successful. 2500 w. Eng Rec—Sept. 8, 1906. No. 79033.

Electrolysis.

Dr. Haber's Report on Electrolysis at Karlsruhe. A special report on the stray tramway currents at Karlsruhe, and the harm they are likely to do to the gas and water pipes. 4500 w. Jour Gas Lgt—Aug. 28, 1906. No. 79104 A.

Electrolysis of Underground Pipes. Putnam A. Bates. Gives results of tests and investigations made, stating the facts disclosed and discussing the cause and effect of stray currents and the methods of preventing and guarding against this trouble. 3800 w. R R Gaz—Aug. 31, 1906. No. 78967.

Filtration.

A Rapid Sand Filter Plant in Germany. Edmund B. Weston. Illustrated description of a plant recently completed at the large dyeing and bleaching works in Gera, Germany. 900 w Eng Rec—Sept. 8, 1906. No. 79031.

The Life-History for Eight Years of the Experimental Coke Clinker Filter-Beds at Kingston-on-Thames. Douglas Archibald. Abridged paper. Read before the Roy. San. Inst. An account of results from the working of these beds, showing what can be done by single filtration of a high-class chemical effluent, from which solids have been eliminated. 2800 w. Eng Rec—Sept. 22, 1906. No. 79429.

Ground Water.

Total Amount of Free Water in the Earth's Crust. Myron L. Fuller. Abstract from paper No. 160, U. S. Geol. Survey. Considers the total free water in rocks of various types, and underground conditions. 2000 w. Min Rept—Aug. 30, 1906. Serial. 1st part. No. 78042.

Map Symbols.

Representation of Wells and Springs on Maps. Myron L. Fuller. Suggestions for a system to secure uniformity. 1300 w. Eng News—Sept. 13, 1906. No. 79172.

Ozone.

A New Ozone Water-Sterilizing Equipment. Frank C. Perkins. Illustrated description of apparatus and methods of operation of a new system for the sterilization of water by means of ozone, electrically produced. The Siemens-Schuckert equipment. 1000 w. Elec Rev, N Y—Sept. 1, 1906. No. 78923.

Pipe Line.

The Pipe Line of the New Gravity Water Supply of Lynchburg, Va. Illustrated description of a pipe line 30 in. in interior diameter and about 110000 ft. long, consisting of 99000 ft. of wood stave pipe, 7000 ft. of lock-bar steel pipe, and 4000 ft. of cast-iron pipe. 3000 w. Eng Rec—Sept. 1, 1906. No. 78924.

Pure Water.

The Value of Pure Water. George C. Whipple. A study of different characteristics of water and what they cost the consumer, and of the prices consumers are willing to pay to avoid using waters which possess certain characteristics. 4500 w. Eng Rec—Sept. 8, 1906. Serial. 1st part. No. 79036.

Springs.

The Impounding of Springs (Captage des Sources). M. Lidy. Discussing the enclosing of springs or other ground water supplies to prevent contamination from local or surface drainage, with especial reference to the water supply of Brest, France. 2000 w. Ann d Ponts d Chaussées—2 Trimestre, 1906. No. 79333 E+F.

Supply.

Carlisle's New Water-Works. Illustrated description of this British system which utilizes springs and streams which form the headwaters of the river Gelt. 2000 w. Engr, Lond—Aug. 24, 1906. No. 79017 A.

WATERWAYS AND HARBORS.

Canal Traction.

The American Canal Towing System of Wood and the Double-Rail Locomotive System (Das Amerikanische Schleppschiffahrts System Wood und das Zweigleisige Lokomotiv System). C. Köttgen. A comparison of the single I-beam system with the electric trolley system on the Teltow canal. 4000 w. Elektrotech Zeitschr—Aug. 9, 1906. No. 79-347 B.

The Teltow Canal and Its Equipment. Based on articles which have appeared in the *Elektrotechnische Zeitschrift*. Begins an illustrated description of this German Canal. Also editorial. 3300 w. Elect'n, Lond—Sept. 14, 1906. Serial. 1st part. No. 79454 A.

Conveyors.

See Mechanical Engineering, Power and Transmission.

Crane.

Floating Crane of 25 Tons Capacity (Schwimmkran von 25 t. Tragkraft). R. Dub. Illustrating a powerful floating steam crane built by Petravic of Vienna, for the Austrian Lloyds at the port of

Trieste. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 1, 1906. No. 79309 D.

Docks.

Ore Dock Improvements at Ashtabula. Plan and description of the large modern ore unloading dock being erected at this Lake Erie port. 1300 w. Ir Trd Rev—Sept. 29, 1906. No. 79278.

Dredges.

Experience with the U. S. Dredges "Manhattan" and "Atlantic," Employed upon Ambrose Channel, New York Harbor. Henry N. Babcock. A report giving a general description of the dredges, the character of the material dredged, data concerning the work, alterations, repairs, costs, etc. Ills. 6500 w. Eng News—Sept. 20, 1906. No. 79285.

Italy.

The Maritime Ports of Italy (Les Ports Maritimes d'Italie). Baron Quinette de Rochemont and M. G. de Joly. An exhaustive study of the commercial and engineering features of Italian seaports, followed by a detailed description of the harbors of Genoa, Naples, and Venice. 20000 w. 6 plates. Am d Ponts et Chaussées—2 Trimestre, 1906. No. 79331 E + F.

Lake Port.

Port of Ashtabula. An illustrated article giving the history of this Lake Erie port, and showing the wonderful transformations that have taken place. 4000 w. Marine Rev—Sept. 20, 1906. No. 79298.

Lighthouse.

The Construction of a Concrete Tower for the French Lighthouse Service. Illustrated description by M. Alexandre, translated from the *Annales des Ponts et Chaussées*. 2000 w. Cement—Sept., 1906. No. 79260 C.

Locks.

A Logical Solution of the Lock Question at the Sault. R. J. McKeone. Describes the type of lock recommended for fast operation. 1800 w. Marine Rev—Sept. 13, 1906. No. 79181.

Rhine.

The Industrial Harbors of the Lower Rhine (Die Niederrheinischen Industriehäfen). Paul Berkenkamp. With especial reference to the equipment of harbors with mechanical handling appliances for the coal and iron trade. Map. 4000 w. 1 plate. Stahl u Eisen—Sept. 1, 1906. No. 78369 D.

Ship Canal.

Lake Erie and Ohio River Ship Canal from Ashtabula to Pittsburg. Maps and information concerning this project. 2000 w. Marine Rev—Sept. 20, 1906. No. 79299.

MISCELLANY.

Earthquakes.

Earthquakes Along the Coast of South America. A. Lakes. Gives notes from the journal of Charles Darwin describing an earthquake in this region. 1400 w. Min Rept—Sept. 6, 1906. No. 79065.

ELECTRICAL ENGINEERING

COMMUNICATION.

Overland Route.

A Brief History of the Overland Telegraph Line from America to Europe. Extract from the report of the Minister of Mines, British Columbia, giving an account of the Collins Overland Telegraph Co.'s lines, begun in 1865 and abandoned in 1866 when the Atlantic cable was successfully laid. 1700 w. Eng News—Sept. 6, 1906. No. 79091.

Printing Telegraph.

The Murray Automatic Page-Printing Telegraph—Its History and Its Progress. Photograph with account of the development. 1600 w. Sci Am—Sept. 8, 1906. No. 79080.

Railroad Telegraphs.

The Traffic of Railway Communication. Frank E. Fowle. Read before the Assn. of Ry. Telegraph Supts. A plea for a broader view of the functions of a telegraph department and its relation to the question of railway communication. 3000 w. Ry Age—Sept. 7, 1906. No. 79073.

Space Telegraphy.

Directed Wireless Telegraphy. H. J. Round. Discussion of the results recorded in Marconi's paper before the Royal Soc. of London. Diagrams. 1000 w. Elec Wld—Sept. 22, 1906. No. 79476.

The Tuning of Transmitters for Space Telegraphy (Ueber die Abstimmung Funkentelegraphischer Sender). Max Wien. Discussing especially the late researches of Dr. Slaby, and the theory developed from them. 6000 w. Elektrotech Zeitschr—Sept. 6, 1906. No. 79359 B.

Wave Lengths in Wireless Telegraphy. H. J. Round. Gives results of experiments on the effect of varying the wave length used between two wireless sta-

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tions with land between them. 700 w. Elec Wld—Sept. 15, 1906. No. 79248.

Wireless Telegraphy and Mr. Marconi. J. Henniker-Heaton. In defense of Marconi's great invention. 4000 w. Nineteenth Cent—Sept., 1906. No. 79276 D.

Telephony.

How to Improve Telephony. W. Duddell. Lecture before the Royal Inst. Presents some of the problems of telephony and the methods of measurement available. Diagrams. 2000 w. Elec Engr, Lond—Aug. 24, 1906. No. 78999 A.

DISTRIBUTION.

Cables.

Discussion on "Standardizing Rubber-Covered Wires and Cables," and "Comments on Present Underground Practice," at New York, April 27, 1906, and at Minnesota Branch, May 4, 1906. 10500 w. Pro Am Inst of Elec Engrs—Aug., 1906. No. 79266 D.

Experimental Researches on the Heating of Cables by Three Phase Currents Erwärmungsversuche mittels Drehstromes an Kabeln). Diagrams and tables of tests made by the Köln-Nippes cable works. 1800 w. Elektrotech Zeitschr—Aug. 30, 1906. No. 79357 B.

The Space Factor of Cables and Considerations Controlling Their Cost. H. M. Hobart. Aims to arrive at more tangible data from which to work out estimates of the cost of the high-tension transmission lines. 1700 w. Elec Engr, Lond—Sept. 14, 1906. Serial. 1st part. No. 79442 A.

Conductors.

Overhead Wires or Cables? (Freileitung oder Kabel?) Louis Bernard. A tabular comparison of costs, both of construction and operation in a city distribution system for overhead wires and underground cables. 2500 w. Elektrotech u Maschinenbau—Aug. 19, 1906. No. 79361 D.

Currents.

Central Station Light, Heat and Power Principles. Newton Harrison. Explains phases of current, two-phase, three-phase, etc. 1500 w. Cent Sta—Sept., 1906. No. 79083.

Grounding.

Experience with Grounded Neutral in a High-Tension Plant. C. W. Ricker. Discusses the experience of the Interborough Rapid Transit Co., of New York. Also editorial. 4400 w. Elec Jour—Sept., 1906. No. 79265.

Lines.

Line Construction for Overhead Light and Power Service. Paul Spencer. Discusses line construction, especially overhead construction; the safety and reliability of the lines and the sightliness of the construction. Ills. 4000 w. Can Elec News—Sept., 1906. No. 79189.

Switches.

Automatic Oil Switches for High-Pressure Alternating Currents (Selbsttätige Hochspannungs Oelschalter für Wechelstrom). Karl Kuhlmann. A discussion of the advantages of oil switches made by the *Allgemeine Elektrizitäts Gesellschaft.* 4000 w. Elektrotech Zeitschr—Aug. 9, 1906. No. 79346 B.

Wiring.

Wiring and Lighting Equipment of an Eight-Room $3,500 Residence. J R Cravath. Extracts from a paper read before the Ohio Elec. Lgt. Assn., outlining a number of plans. 3500 w. Elec Wld—Sept. 1, 1906. No. 78977.

ELECTRO-CHEMISTRY.

Accumulators.

Premier Accumulator Tests. Report of Dr. R. T. Glazebrook on a complete series of tests carried out at the National Physical Laboratory on this type of cell. 600 w. Elec Rev, Lond—Aug. 24, 1906. No. 79002 A.

Cadmium Cell.

The Cadmium Standard Cell. George A. Hulett, in the *Physical Review.* A study of these cells giving results. 3500 w. Serial. 1st part. No. 79457 A.

Cyaniding.

Studies in the Electrolytic Separation of Gold from Cyanide Solutions (Studien zur Elektrolytischen Fällung des Goldes aus Cyanidlösungen). Dr. B. Neumann. A review of practical experience, with diagrams showing results for various current-densities and solutions. 4000 w. Zeitschr f Elektrochemie—Aug. 10, 1906. No. 79365 G.

The Electrolytic Deposition of Gold from Cyanide Solutions. Editorial review on a paper by Prof Bernh. Neumann, describing investigations made to determine the current efficiency from solutions of different concentration; whether a high or low current was the more economical and whether other electrodes than lead and iron could be used. 1200 w. Elect'n, Lond—Aug. 24, 1906. No. 79005 A.

Electric Furnace.

New Experiments on Formation of Diamond in Electric Furnace. Prof. Henri Moissan. A report of an experimental study. 1600 w. Sci Am Sup—Sept. 8, 1906. No. 79081.

Electric Smelting.

The Electrothermal Metallurgy of Iron. Major E. Stassano. Gives a résumé of the present position of electrothermal metallurgy, describing two types of fur-

nace, and giving results of experiments. Ills. 6800 w. Elect'n, Lond—Sept. 7, 1906. No. 79222 A.

Nickel Plating.

A Serviceable Black Nickel Solution. Frank Noir. Gives the black nickel solution found satisfactory by the writer, and directions for operating it. Ills. 1500 w. Brass Wld—Aug., 1906. No. 79493.

Nitrogen.

The Electrical Fixation of Atmospheric Nitrogen (Die Darstellung von Stickstoff-Sauerstoff Verbindungen aus Atmosphärischer Luft auf Elektrischem Wege). Dr. O. Kausch. A critical review of the various patents since 1902. 3500 w. Elektrochemische Zeitschr—Aug., 1906. No. 79366 G.

Oxygen.

The Liquefaction of Air and Processes of Separating Oxygen (Ueber Luftverflüssigungs und Sauerstoffgewinnungs Verfahren). Rudolf Mewes. A review of the thermodynamics of the liquefaction of air, with reference to the commercial production of oxygen. Serial. Part 1. 3000 w. Elektrochemische Zeitschr—Sept., 1906. No. 79367 G.

Ozone.

An Improved Ozone Generator. Charles H. Coar. An explanation of what ozone is, and a brief account of its discovery, with illustrated description of an improved generator. 1800 w. Sci Am—Sept. 29, 1906. No. 79500.

ELECTRO-PHYSICS.

Alternating Waves.

The Effect of Iron in Distorting Alternating-Current Wave Form. Frederick Bedell and Elbert B. Tuttle. A theoretical study of the harmonics introduced by iron into the current wave, particularly the third harmonic, and the hysteresis loop of the iron to which these harmonics are due. Curves and tables. 3500 w. Am Inst of Elec Engrs—Sept. 28, 1906. No. 79508 D.

Electrical Discharge.

The Electrical Discharge in Air, and Its Commercial Application. Sidney Leetham and William Cramp. Read before the British Assn. A report of investigations, describing the construction and application of the apparatus developed, the electrical phenomena involved, and the chemical phenomena. Ills. 7800 w. Elec Engr, Lond—Aug. 24, 1906. No. 78996 A.

Electrical Oscillations.

The Effect of Electrical Oscillations on Iron in a Magnetic Field. W. H. Eccles. Abstract of a paper read before the Physical Soc. Reports investigations of the action of high-frequency oscillations upon iron held magnetized in a magnetic field. 2000 w. Elect'n, Lond—Aug. 24, 1906. No. 79006 A.

Induction.

On the Electric Inductive Capacities of Dry Paper and of Solid Cellulose. Albert Campbell. Read before the Royal Soc. Reports tests made on samples of paper obtained from four different cable manufacturers, describing methods of testing. 2500 w. Elect'n, Lond—Aug. 31, 1906. Serial. 1st part. No. 79133 A.

Magnetic Fields.

Some Phenomena of Single-Phase Magnetic Fields. B. G. Lamme. Gives costs and methods of analyzing the single-phase field, furnishing a simple explanation of certain characteristics of single-phase machinery. 2400 w. Elec Jour—Sept., 1906. No. 79264.

The Rotating Magnetic Field. R. E. Hellmund. A discussion of the nature of rotating magnetic field, its distribution, and the pole faces, its speed of rotation, etc. Considers in detail a threephase motor with one slot per pole per phase in both members. 2800 w. Elec Rev, N Y—Sept. 22, 1906. No. 79415.

Magnets.

Characteristic Performance of Polyphase Magnets. D. L. Lindquist. An investigation of the influence exerted by the coil resistance and also the external resistance. Ills. 2000 w. Elec Wld—Sept. 22, 1906. No. 79475.

GENERATING STATIONS.

Alternators.

Self-Exciting, Low-Frequency Alternator. G. Faccioli. Discusses an interesting self-exciting generator devised by William Stanley, giving an outline description. Also editorial. 4500 w. Elec Wld—Sept. 15, 1906. No. 79247.

The Sudden Short-Circuiting of Alternators. F. Punga. A study of the factors that effect the difference between a gradual short circuit and a sudden short circuit. Gives an approximation to that which actually happens. 2700 w. Elect'n, Lond—Aug. 31, 1906. No. 79132 A.

Baltimore.

The Westport Power Plant at Baltimore, Md. Illustrated description of an electric generating station with a capacity of 33000 h. p. The building is of reinforced concrete. 4000 w. Eng Rec—Sept. 1, 1906. No. 78925.

Westport Station of the Consolidated Gas, Electric Light and Power Company of Baltimore. Illustrated description of this power station and its equipment. The building is of reinforced concrete. 4500 w. Elec Wld—Sept. 1, 1906. No. 78976.

Brushes.

Carbon Brushes v. Copper. E. Austin. Briefly considers the merits and demerits

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of the two kinds of brushes, urging the use of copper brushes for certain classes of machines. 900 w. Elec Engr, Lond—Aug. 30, 1906. No. 78126 A.

Tests on Dynamo Brushes. An account of tests, carried out under Prof. Arnold, consisting in the measurement of the voltage drop at different current densities between brushes of various qualities and a slip-ring rotated at various speeds. 2000 w. Elec Engr, Lond—Sept. 7, 1906. No. 79215 A.

Charges.

Equitable Charging for the Supply of Energy by Municipal Electricity Undertakings. J. Horace Bowden. Shows that neither the maximum demand nor the flat rate systems are equitable, and submits a system considered just and expedient. 1800 w. Elec Rev, Lond—Aug. 31, 1906. No. 79128 A.

Combined Plant.

A Combination Ice Making and Lighting Plant. Illustrated description of a new plant at Caruthersville, Mo., and discusses the advantages of combining electric lighting, ice-making and cold storage plants. 2500 w. Ice & Refrig—Sept., 1906. No. 78919 C.

Economies.

The Easiest Place to Work Central Station Economies. R. B. Holbrook. Considers the economies needed in the boiler-room. 2000 w. Elec Wld—Sept. 1, 1906. No. 78981.

Electric Machinery.

High-Speed Electric Machinery, with Special Reference to Steam-Turbine Machines. Prof. Silvanus P. Thompson. Howard lecture. Discusses the problems of electric design as affected by speed and rated output in this first lecture. Ills. 6200 w. Jour Soc of Arts—Sept. 14, 1906. Serial. 1st part. No. 79437 A.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Hydro-Electric.

Electric Generating Station of the Holyoke Water Power Company. Illustrated detailed description of the largest water-power in New England, furnishing power for large paper mills and other industries. 3500 w. Elec Wld—Sept. 15, 1906. No. 79246.

Electric Power from Southern Waterfalls. J. W. Fraser. Reviews the water power situation in the south since the introduction of the electric drive, and the progress of this work. Ills. 4500 w. Elec Rev, N Y—Sept. 8, 1906. No. 79051.

The Hydro-Electric Station at St. Cézaire on the Siagne (L'Usine Hydro-Electrique de la Siagne à Saint Cézaire). P. Chignaterie. Describing the tunnel and pipe line, with plans and details of the power station. The plant is to be operated with that at Entraygues, in the south of France, near Cannes. 2000 w. 1 plate. Génie Civil—Aug. 25, 1906. No. 79318 D.

The New Hydro-Electric Station of the Holyoke Water Co. The first of a series of articles giving an illustrated detailed description of this important plant, which furnishes power for large paper mills and other purposes. 2500 w. Eng Rec—Sept. 15, 1906. Serial. 1st part. No. 79156.

The Truckee River General Electric Company. Extract from a forthcoming volume by A. W. Clapp. Illustrated description of the plant constructed to supply power to the Comstock mines, Nevada, and of additional plants. 2400 w. Elec Rev, N Y—Sept. 22, 1906. No. 79416.

Water-Power Station at Launceston, Tasmania. A. Martinek and A. Lauri. Abstract translation from *Elektrotechnische Zeitschrift*. Describes a turbine station, the water-power being derived from the South Esk River, and transmitted three miles. 1400 w. Elect'n, Lond—Aug. 24, 1906. No. 79004 A.

Municipal Plant.

The Frankfort Central Station. B. F. Hirschauer. Illustrated description of a large German municipal power plant. 2500 w. Elec Rev, N Y—Sept. 15, 1906. No. 79164.

Short-Circuiting.

The Sudden Short-Circuiting of Polyphase Generators (Der Plotzliche Kurzschluss von Drehstromdynamos). F. Punga. A mathematical analysis of the difference in the effects of gradual and sudden short-circuits in alternators. 5000 w. Elektrotech Zeitschr—Sept. 6, 1906. No. 79358 B.

Transformers.

Properties of the Series Transformer. W. B. Gump. Gives an explanation of characteristics of the series transformer. Diagrams. 1700 w. Elec Wld—Sept. 1, 1906. No. 78979.

The Current Transformer. Kenneth L. Curtis. A study of transformers used in connection with electric meters, in order to convert the line currents into currents which are within the safe working limits of the meter. Diagrams, formulæ, and curves. 1700 w. Am Inst of Elec Engrs—Sept. 28, 1906. No. 79509 D.

LIGHTING.

Glow-Lamps.

Notes on Glow-Lamp Standards and Glow-Lamp Photometry. J. S. Dow. On methods of testing and comparing. 2500 w. Elect'n, Lond—Sept. 14, 1906. No. 79455 A.

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Illumination.

Illumination. Prof. W. S. Franklin and Prof. William Esty. A condensed chapter from a book by the authors. Deals with problem of efficient lighting of rooms. 2400 w. Elec Wld—Sept 1, 1906. No. 78978.

Osram.

The Osram Lamp (Die Osram-Lampe). Data and results of tests by the Reichsanstalt upon the new incandescent electric lamp of Dr. Auer von Welsbach. 2000 w. Elektrotech Zeitschr—Aug. 9, 1906. No. 79348 B.

Photometry.

See Electrical Engineering, Measurement.

Tungsten.

The Tungsten Lamp. Gives a review of what has been done towards the development of this new lamp, especially work in Europe and the facts relating to the preparation of the filaments. 4000 w. Elec Wld—Sept. 1, 1906. No. 78975.

MEASUREMENT.

Diagram.

The General Polyphase Diagram (Das Allgemeine Drehstrom-Diagramm). F. Niethammer. Deriving a polar diagram for the graphical solution of problems relating to generators, motors, transformers and regulators. Two articles, 8000 w. Elektrotech u Maschinenbau—Aug. 12, 19, 1906. No. 79360 each D.

Electrical Units.

On the Experimental Determination of the Ratio of the Electrical Units. Lord Rayleigh. Suggestions in regard to the principal determinations, the methods, etc. 1500 w. Elect'n, Lond—Sept. 7, 1906. Serial. 1st part. No. 79226 A.

Frequencies.

The Measurement of Frequencies of Alternating Currents (Verfahren zur Messung von Wechelstrom-Frequenzan). W. Peukert. Describing the use of the method of measuring frequencies by weighing a coil of which the coefficient of self-induction is known. 1800 w. Elektrotech Zeitschr—Aug. 16, 1906. No. 79350 B.

Galvanometers.

The Alternating-Current D'Arsonval Galvanometer. W. S. Franklin and L. A. Freudenberger. Describes an instrument of the shunt magnet type, said to be almost as sensitive as the direct-current instrument. 800 w. Elec Wld—Sept. 22, 1906. No. 79477.

The Theory of "Moving Coil" and Other Kinds of Ballistic Galvanometers. Prof. Harold A. Wilson. Develops the proper formulæ for ballistic galvanometers of several types in general use. 1000 w. Elect'n, Lond—Sept. 14, 1906. No. 79456 A.

Meters.

Limitations of Three-Wire Energy Motor-Meters. H. G. Solomon. Aims to show that the three-wire energy motor meter correctly measures the energy consumption under certain conditions only. 1200 w. Elec Rev, Lond—Aug. 31, 1906. Serial. 1st part. No. 79129 A.

Phase Differences.

The Measurement of Phase Differences. Charles V. Drysdale. Considers experimental methods of phase measurements at high power factors, at low power factors and of small differences of phase. Diagrams. 2000 w. Elect'n, Lond—Aug. 24, 1906. Serial. 1st part. No. 79003 A.

Photometry.

Color Phenomena in Photometry. J. S. Dow. Read before the Physical Soc. An account of experiments carried out by the writer on an ordinary photometrical bench. 5000 w. Elect'n, Lond—Aug. 24, 1906. No. 79007 A.

Resistances.

Experiments on Water Resistances. Karl Wallin. Abstract translation from *Elektrotechnische Zeitschrift.* Gives results of experiments carried out in the Technical High School at Stockholm. 1000 w. Elect'n, Lond—Sept. 7, 1906. No. 79225 A.

Some Experiments with Water Resistances (Einige Untersuchungen über Wasserwiderstände). Karl Wallin. A discussion of errors which may occur in the use of water resistances in tests of electrical machinery. 1800 w. Elektrotech Zeitschr—Aug. 9, 1906. No. 79345 B.

Testing.

Accurate Speed, Frequency and Acceleration Measurements. Charles V. Drysdale. A review of the methods of testing in general use. Ills. 2000 w. Elec Rev, Lond—Sept. 7, 1906. Serial. 1st part. No. 79219 A.

Time Measurements.

The Practical Application of Electricity to the Determination of Intervals of Time (Die Praktische Anwendung Direkter Zeitbestimmung im Messwesen der Schwachstromtechnik). H. C. Steidle. Describing the application of condenser discharges to the measurement of the time action of electric relays. 6000 w. Elektrotech Zeitschr—Aug. 16, 1906. No. 79349 B.

Windings.

On the Rapid Calculation of Field Coil Windings. George T. Hanchett. Gives tables useful in facilitating calculations, explaining their application. 1100 w. Elec Wld—Sept. 8, 1906. No. 79198.

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MOTORS.

Brush Holders.

Importance of Effective Brush-Holder Inspection. Henry Schlegel. Explains the functions required of brush-holders and considers the troubles incident to irregularities in the brush gear. 4000 w. St Ry Jour—Sept. 8, 1906. No. 79041 C.

Care.

The Ill-Treatment of Electric Motors. Considers the causes of breakdowns due to ill-treatment. 1500 w. Mech Engr—Aug. 25, 1906. No. 78993 A.

Commutation.

Commutation in a Four-Pole Motor. J. K. Catterson-Smith. Reports results of investigations made with a view to recording by means of the oscillograph the actual manner in which the current is reversed during commutation. Diagrams. 2400 w. Elec Engr, Lond—Aug. 24, 1906. No. 78997 A.

Interpole.

The Influence of Interpoles upon the Design of Continuous-Current Motors (Betrachtungen über den Einfluss des Wendepoles auf den Entwurf Normaler Gleichstrommaschinen). W. Oelschläger. Showing the increase in capacity and general structural advantages obtained by the use of interpoles. 3000 w. Elektrotech Zeitschr—Aug. 23, 1906. No. 79352 B.

Regulation.

The Voltage Regulation of the Continuous-Current Dynamo. H. M. Hobart. Describes a satisfactory method of predetermining the regulation of continuous-current dynamos, chiefly by reference to the 550-K. W. dynamo. 1400 w. Elec Rev, Lond—Aug. 24, 1906. No. 79000 A.

Single Phase.

Alternating-Current Commutator Motors (Ueber Wechselstrom-Kommutatormotoren). F. Eichberg. A comparison of the series motor with the compensated repulsion motor. 4000 w. Elektrotech Zeitschr—Aug. 16, 1906. No. 79351 B.

Calculation of Starting Apparatus for Single-Phase Induction Motors. Suggests a simple graphical method for the predetermination of the starting torque, and for a rational calculation of the starting phase and starting apparatus in the single phase induction motor without commutator. 1800 w. Elec Rev, Lond—Aug. 24, 1906. No. 79001 A.

Commutation in Single-Phase Motors at Starting. Marius Latour. Gives a mathematical and a graphical representation. 1000 w. Elec Wld—Sept. 8, 1906. No. 79199.

The Theory of Single-Phase Commutator Motors, with Reference to Leakage (Die Theorie der Emphasigen Kommutatormotoren mit Berücksichtigung der Streuung). Dr. A. Thomälen. A mathematical analysis of the losses in single-phase motors, reviewing the discussion of Sumec. 2500 w. Elektrotech u Maschinenbau—Sept. 9, 1906. No. 79363 D.

TRANSMISSION.

Arresters.

The Benefit of Enquiry in Lightning-Arrester Practice. N. J. Neale. Discusses needed investigation of lightning-protection apparatus, and the information available concerning the performance of apparatus now in use. 3500 w. Elec Rev, N Y—Sept. 8, 1906. No. 79050.

Insulators.

The Samenza Porcelain Insulator at the Milan Exhibition. Illustrates and describes a new insulator devised and perfected by Italian engineers. 1000 w. Elec Rev, Lond—Aug. 31, 1906. No. 79131 A.

Line Measurements.

Measurements on Lines without Using Testing Wires (Ueber Fernspannungs-Messung ohne Prüfdrähte). G. Rasch. Describing the use of measuring transformers for the determination of the voltage at the end of a line. 1800 w. Elektrotech Zeitschr—Aug. 30, 1906. No. 79355 B.

Lines.

Power Transmission Lines. T. L. Kolkin. Discusses important points in the laying out of transmission lines. 1200 w. Elec Rev, Lond—Sept. 14, 1906. Serial. 1st part. No. 79444 A.

Overhead.

English Overhead Transmission Lines and Distribution Mains. Gives recent regulations issued by the Board of Trade, and an account of overhead work being carried out. Ills. 2600 w. Elec Engr, Lond—Sept. 14, 1906. Serial. 1st part. No. 79443 A.

MISCELLANY.

Address.

The Work of the Institute. Samuel Sheldon. Presidential address before the American Inst. of Elect. Engrs., showing the scope of the Institute's activities, and describing the work of the secretary's office and of the various committees. 3500 w. Am Inst of Elec Engrs—Sept. 28, 1906. No. 79507 D.

Paris.

The Future Régime of Electricity in Paris. An explanation of the situation in regard to the supply and distribution of electrical energy. The city is at present supplied by six companies, called the six Sectors, whose concessions are about to expire. 900 w. Elec Rev, Lond—Sept. 14, 1906. No. 79447 A.

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INDUSTRIAL ECONOMY

Austria.

Austria and Her Industries. An account of the special aid rendered by the Government for the encouragement of industry, illustrating some of the shops. 2500 w. Engr, Lond—Aug. 31, 1906. No. 79149 A.

Development.

The Development of the West. C. A. Cairns. Extracts from an address at a meeting of the Int. Assn. of Ticket Agents. Historical review of the progress and causes that have contributed to the wonderful growth. 1500 w. Ry Age—Sept. 7, 1906. No. 79074.

Industrial Training.

An Experiment in Industrial Training. Magnus W. Alexander. An illustrated article explaining the apprenticeship system of the General Electric Co., at West Lynn, Mass. 4000 w. Mach, N Y—Sept., 1906. No. 78962 C.

Labor.

Philippine Labor. L. E. Bennett. Gives information concerning native labor in various parts of the islands, and the traits of character; their adaptability and skill in the use of mechanical appliances, etc. Ills. 3500 w. R R Gaz—Sept. 7, 1906. No. 79101.

The Democrazation of Industry, or Enlightened Methods of Treating the Employed. H. F. J. Porter. Discusses the progress and improvements recently introduced for the betterment of employees, and their comfort, and the results. Ills. 3000 w. Jour Fr Inst—Sept., 1906. No. 79261 D.

The Labor Problem in Great Britain. T. Good. Gives a proposed solution after explaining present conditions. 3000 w. Cassier's Mag—Sept., 1906. No. 79252 B.

The United States Eight-Hour Law; Its Constitutionality and Construction. William B. King. A discussion of the provisions of this law. 4000 w. Eng Rec—Sept. 8, 1906. Serial. 1st part. No. 79038.

Museums.

The Practical Value of Industrial Museums. Alfred Sang. A discussion of the value of the industrial museum as a force in educating and directing invention and productive energy. 3500 w. Engineering Magazine—Oct., 1906. No. 79381 B.

Patents.

Patents as a Factor in a Manufacturing Business. Edwin J. Prindle. The second paper discusses the nature of the protection which a patent affords to its owner, with examples of various cases. 5000 w. Engineering Magazine—Oct., 1906. No. 79387 B.

Reichsanstalt.

The Work of the Reichsanstalt in 1905. Editorial review of the report for this year. 5000 w. Engng—Aug. 31, 1906. No. 79142 A.

MARINE AND NAVAL ENGINEERING

Armor.

Armor and Its Attack. N. E. Edwards. Read before the British Assn. Reviews the history of armor protection for ships and its development, manufacture, etc. Ills. 4500 w. Engr, Lond—Sept. 7, 1906. No. 79242 A.

Armor and Ships. Prepared for use in the Department of Artillery, U. S. Artillery School. Considers armor and methods of securing it to the ship, penetration of projectiles, structural arrangement of ships, etc., etc. Ills. 28500 w. Jour U S Art—July, 1906. No. 79487 D.

Assistant Cylinders.

Performance of the Assistant Cylinders of the Washington. W. W. Smith. Gives the performance of the assistant cylinders, comparing the performance of assistant and balance cylinders, installed on similar engines and working under the same conditions, and describes a practical method of analyzing the indicator cards and working out the results. 6500 w. Jour Am Soc of Nav Engrs—Aug., 1906. No. 79485 H.

Battleships.

H. M. Battleship Lord Nelson. Description of this vessel, with an account of its launching. 2000 w. Engr, Lond—Sept. 7, 1906. No. 79238 A.

U. S. Battleship Georgia. Clifton Lee, Jr. Illustrated description with report of trials. 6000 w. Jour Am Soc of Nav Engrs—Aug., 1906. No. 79481 H.

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U. S. Battleship New Jersey. Illustrated description with report of official trial. 3500 w. Jour Am Soc of Nav Engrs—Aug., 1906. No. 79483 H.

Coal Storage.

The New Floating Coal Depot in Portsmouth Harbor. Frank C. Perkins. Illustrates and describes an interesting plant for the British Admiralty, for storing great quantities of coal afloat under the most favorable conditions. 1000 w. Marine Engng—Oct., 1906. No. 79468 C.

Cruisers.

Description and Official Trials of the U. S. S. Washington. William A. Leavitt, Jr. Illustrated detailed description of the vessel, its equipment, and trials. 2500 w. Jour Am Soc of Nav Engrs—Aug., 1906. No. 79480 H.

H. M. S. Natal. Illustrated description of this warship and its equipment. 1500 w. Engr, Lond—Aug. 24, 1906. No. 79019 A.

U. S. S. St. Louis. James Nelson Alexander. Illustrations, description, and report of official trial. 8000 w. Jour Am Soc of Nav Engrs—Aug., 1906. No. 79478 H.

Evaporators.

Marine Evaporators. John Neill. Describes various makes, their construction and working, explaining the necessity which led to their adoption on all classes of steamships. Plate. 5500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Aug., 1906. No. 79256 D.

Fire-Boat.

A Large Motor Fire-Boat. Illustrated description of a powerful boat for Huelva, Spain. 600 w. Auto Jour—Sept. 1, 1906. No. 79111 A.

Fire-Extinguishing.

Fire-Extinguishing Apparatus on Board Ship. Illustrated description of the fire-extinguishing apparatus installed on the S. S. Aydon, which uses sulphur dioxide gas in place of water or steam. 1100 w. Engr, Lond—Sept. 7, 1906. No. 79239 A.

Gyroscope.

The Gyroscopic Action of Rotating Fly Wheels on Shipboard (Gyroskopischen Einfluss Rotierender Schwunräder an Bord von Schiffen). O. Schlick. A discussion of the practicability of employing heavy rotating wheels to lessen the rolling of ships. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 8, 1906. No. 79312 D.

Harbor Vessel.

Harbor Service Vessel for the Midland Railway Company. Illustrations, with brief description of the "Wyvern" for service at Heysham Harbor. 200 w. Engng—Aug. 24, 1906. No. 79009 A.

Indicator.

Depth Indicator for Torpedo Boats. Illustrates and describes an interesting apparatus devised by Elliott Bros. of London, based on results of experiments carried out by Harold Yarrow, of the firm of naval shipbuilders. 1500 w. Sci Am Sup—Sept. 29, 1906. No. 79505.

Liner.

The Cunard Express Liner "Mauretania." An illustrated article giving description and full particulars in regard to the construction and equipment of this fine Cunard steamship. Plates. 7500 w. Engng—Sept. 14, 1906. No. 79449 A.

Marine Engines.

A Compound Engine Design. Drawings and description. 1000 w. Marine Engng—Oct., 1906. No. 79467 C.

Marine Railway.

How to Build a Small Marine Railway. Charles G. Davis. An illustrated article describing in detail the construction of a railway for a yacht yard. 3800 w. Rudder—Sept., 1906. No. 79028 C.

New Route.

Opening of a New Route to Ireland. An illustrated account of the new route opened from Fishguard to Rosslare. A scheme of the Great Western Company. The present article describes the Fishguard works. 4800 w. Engr, Lond—Aug. 31, 1906. Serial. 1st part. No. 79145 A.

Propulsion.

The Del Proposto System of Electrical Transmission Gear for the Propulsion of Ships by Irreversible Engines. Describes an electrical method of power transmission, more particularly intended for application to Diesel engines. Ills. 1700 w. Elect'n, Lond—Sept. 7, 1906. No. 79224 A.

Shipbuilding.

Where the Ships Are Made. Arthur L. Rice. An illustrated description of the shops and power plant of the New York Shipbuilding Co., at Camden, N. J. 3000 w. Engr, U S A—Sept. 1, 1906. No. 79086 C.

Steamboat.

New Steamboat Hendrick Hudson. Illustrated detailed description of this fine passenger vessel for service on the Hudson River, with report of the first trip. 6000 w. Naut Gaz—Aug. 30, 1906. No. 78961.

Steamships.

New Canadian Steamer Cassandra. Illustration, with description, of a twin-screw steamer having novel features by which passenger space is transformed into cargo space and for the carrying of cattle, and *vice versa*. 1500 w. Engr, Lond—Sept. 7, 1906. No. 79240 A.

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Testing Tank.

The Testing Tank of the French Navy at Paris (Le Bassin d'Expériences de la Marine Française à Paris). L. Piaud. A full account of the construction of the tank, the electric touring bridge and the machine for shaping the paraffine models. The tank is 135 metres long, 10 metres wide and 4 metres deep. 3000 w. 1 plate. Génie Civil—Sept. 8, 1906. No. 79323 D.

Torpedo-Boats.

Some Accidents, Repairs, Etc., to the Vessels of the Torpedo-Boat Flotilla (November, 1901, to January, 1903), and of the First Torpedo Flotilla (January, 1903, to April, 1904). L. H. Chandler. A brief account of the more unusual matters of interest of this cruise. Ills. 5700 w. Jour Am Soc of Nav Engrs—Aug., 1906. No. 79479 H.

Types of French Torpedo Boats. Brief illustrated descriptions. 700 w. Engr, Lond—Sept. 7, 1906. No. 79241 A.

Turbine Steamers.

Characteristics in Design and Arrangement of Marine Turbines and Propellers. Ernest N. Janson. Deals with the Parsons turbine when used for marine purposes. 8000 w. Jour Am Soc of Nav Engrs—Aug., 1906. No. 79484 H.

Combined Piston and Turbine Engines for Ships (Ueber Combinierte Kolbenmaschinen und Turbinenanlagen für Schiffe). Dr. H. Föttinger. With illustrations of various combinations of reciprocating engines for manœuvring, and turbines for direct propulsion. 4000 w. Zeitschr f d Gesamte Turbinenwesen—July 20, 1906. No. 79300 D.

The Belgian Turbine Steamship Princess Elisabeth (Der Belgische Turbinen Postdampfer Princesse Elisabeth). Details of hull, machinery and equipment of a turbine steamer for the mail and passenger service between Ostend and Dover. Serial. Part I. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 8, 1906. No. 79310 D.

Twin Screw Turbine Steamship Oriole. Illustrated detailed description of a steel steamship of the hurricane deck type, fitted with Curtis steam turbines. 3000 w. Marine Engng—Oct., 1906. No. 79466 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air-Cooling.

The Problem of Air-Cooling Petrol Engines. Max A. R. Brunner. An explanation of the scientific principles on which air-cooling is based, describing good examples of American practice. Ills. 3500 w. Autocar—Sept. 1, 1906. Serial. 1st part. No. 79113 A.

Ambulance.

A Motor Ambulance for the United States Army. Waldon Fawcett. Illustrated description of a steam motor vehicle for hospital service. 900 w. Sci Am—Sept. 8, 1906. No. 79078.

Axles.

Automobile Front Axle Construction. Detailed discussion of front axles, their manufacturing methods, types of steering knuckles, etc. Ills. 2000 w. Automobile—Sept. 6, 1906. No. 79085.

Boilers.

Boilers for Motor Cars. Brief illustrated descriptions of various types used on steam motor cars. 400 w. Ry Age—Sept. 21, 1906. No. 79424.

Collisions.

Collision Forces in Automobiles. William F. Durand. Considers some of the conditions which determine the amount of destructive energy liberated. 4000 w. Automobile—Aug. 30, 1906. No. 78910.

Competition.

New Serious Competitors of Electric Motor Cars. An illustrated article giving information concerning the trackless trolley used in Germany and France; the motor omnibuses used in England, etc. 2000 w. Elec Wld—Sept. 8, 1906. No. 79197.

Crank-Shaft.

A High-Grade Car-Motor Crank-Shaft. Hugh Dolnar. Illustrates and describes the crank-shaft of the American "Mercedes" car, and explains why copies of foreign cars cost more than the American cars. Ills. 1800 w. Am Mach—Vol 29. No. 37. No. 79187.

F. I. A. T

The F. I. A. T. Automobiles (Les Voitures Automobiles F. I. A. T.). F. Drouin. An illustrated account of the latest machines of the *Fabrica Italiana di Automobili Torino*, with photographs of the motors and the speed changing gear. 1200 w. Génie Civil—Sept. 1, 1906. No. 79320 D.

Gauge.

The T. & M. Tyre Gauge. Comments on correct inflation versus undue depreciation, and an illustrated description of this tyre tester. 1500 w. Auto Jour—Sept. 1, 1906. No. 79110 A.

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Omnibuses.

Local Automobile Omnibus Service on the Coast of Normandy (Service Régional d'Omnibus Automobiles sur la Côte Normande). Lt. Col. G. Espitallier. With map of the routes, views of the machines, and an account of the development of the service. 3500 w. Génie Civil—Aug. 11, 1906. No. 79314 D.

Racing Cars.

Machines in the Elimination Race for the Vanderbilt Cup. Illustrations of six of the eight different makes of machines, with description of some of them, and report of the result of the race. 2500 w. Sci Am—Sept. 29, 1906. No. 79501.

The Tourist Trophy Cars. Illustrates and describes cars entered for this race. 2000 w. Autocar—Sept. 1, 1906. No. 79115 A.

The Tourist Trophy Type of Car. Some consideration of the tabulated details of the cars entered for this year's race with comparison with 1905 cars, and description of some of the vehicles. Ills. 4000 w. Autocar—Sept. 15, 1906. No. 79436 A.

Regent.

The 18 H. P. Four-Cylinder Regent-Car. Illustrated detailed description of this new car. 1200 w. Autocar—Aug. 25, 1906. No. 78989 A.

Renault.

The 10-14 H. P. Renault Car. Illustrated detailed description of the car recently supplied to H. M. King Edward. 1400 w. Auto Jour—Sept. 15, 1906. Serial. 1st part. No. 79434 A.

Roads.

Roads for Motor Traffic. Editorial discussion of the speed and dust questions in regard to motor cars, and of the roads that will best remedy the latter; reviewing also the report of the Royal Commission on Motor-Cars. 3000 w. Engng—Sept. 14, 1906. No. 79451 A.

Russell.

The 16-H. P. Russell Car—A Canadian Petrol Vehicle. Illustrated detailed description of a light car built in Toronto. 2000 w. Auto Jour—Sept. 8, 1906. No. 79214 A.

Speed Gear.

A New and Compact Change Speed Gear. Illustrated description of the Hassler transmission, for use with propeller shaft-drive. It concentrates the change-speed mechanism, the bevel driving gears, and the differential in a single housing on the rear axle. 1000 w. Automobile—Aug. 30, 1906. No. 78911.

Standard.

The 50 H. P. Standard Six-Cylinder Car. Illustrated detailed description of the constructional features. 2000 w. Autocar—Sept. 1, 1906. No. 79114 A.

Tires.

Hints on the Care of Pneumatic Tires. Suggestions in regard to the inflation and care of tires. 1200 w. Automobile—Sept. 27, 1906. No. 79486.

The Care of Pneumatic Tyres. F. J. J. Glynn. Explains the components of a pneumatic motor tyre, and gives suggestions for preserving their life and securing the best service. 1600 w. Motor Car Jour—Aug. 25, 1906. No. 78987 A.

Wheels.

The Spherola Spring Wheel. Illustrated description. The leading feature is that the springs are always equally compressed, so long as the wheel runs on a smooth road, and when meeting obstacles all the springs are utilized for absorbing the shock. 1200 w. Auto Jour—Sept. 1, 1906. No. 79109 A.

The Warley Spring Wheel. Illustrated description of a wheel where the springs are arranged radially in the vicinity of the hub in a very compact manner. 900 w. Auto Jour—Aug. 25, 1906. No. 78990 A.

Winton.

Details of the 1907 Winton Model M. Line drawings and description of the engine, clutch and transmission mechanism and their working. 1500 w. Automobile—Sept. 20, 1906. No. 79408.

COMBUSTION MOTORS.

Alcohol.

Alcohol as a Fuel in Explosion Motors. Thomas L. White. Begins a review of the properties of alcohol, considered as a fuel for explosion motors. 2200 w. Automobile—Sept. 20, 1906. Serial. 1st part. No. 79407.

Alcohol versus Petrol. A letter from Mr. Radford Cooke, reviewing the efforts made in foreign countries to introduce alcohol and facilitate its industrial use, urging the action of England in this matter. 2000 w. Auto Jour—Sept. 1, 1906. No. 79112 A.

Feed Apparatus.

Liquid Feed Apparatus for Oil Engines. Illustrated description of a device for supplying liquid fuel to the carburetter of an internal-combustion engine. 700 w. Mech Engr—Aug. 25, 1906. No. 78994 A.

Gas Engines.

A New Design of Gas Engine. Illustrates and describes a new design of internal combustion engine, intended to show the most advanced practice. It is of the two-cycle, single-acting, scavenging type, adapted for operation with all classes of fuel, both liquid and gaseous. 2000 w. Eng Rec—Sept. 1, 1906. No. 78927.

We supply copies of these articles. See page 319.

Buckeye Gas Engine. Illustrated description of an engine for direct driving electric generators on suction producer gas. 1200 w. Ry & Eng Rev—Sept. 8, 1906. No. 79077.

Fundamental Principles of Gas Engines and Gas Producers. Robert T. Lozier. Read before the N. Y. Elec. Soc. Considers the commercial efficiency and economy of gas engines, explaining the working. Ills. 3000 w. Sci Am Sup—Sept. 18, 1906. Serial. 1st part. No. 79082.

Internal-Combustion Gas Engines. An outline of the findings of a committee of the Institution of Civil Engineers, appointed to investigate their efficiency. 2500 w. Jour Gas Lgt—Sept. 4, 1906. No. 79105 A.

Notes on Gas Engines. On the governing of gas engines. 1200 w. Elec Rev, Lond—Sept. 14, 1906. No. 79445 A.

Plain Story of an Internal Combustion Engine. Louis J. Buschman. An illustrated explanation of the principles which enter into the construction and operation. 2200 w. Automobile—Sept. 6, 1906. No. 79084.

Tests of a Gas Engine Operated by a Suction Producer. George H. Barrus. Gives description of the plant and the tests made. 3500 w. Cassier's Mag—Sept., 1906. No. 79251 B.

What Makes the Gas Engine Run. E. W. Roberts. Explains the system of operations in the four-cycle type of engine, and the two-cycle type. 2500 w. Rudder—Sept., 1906. No. 79027 C.

Working Drawings of a 7 B. H. P. Gas Engine. Drawings and descriptive notes of a gas engine of the ordinary single-acting Otto type, using as fuel an average quantity of ordinary illuminating gas. 1200 w. Mech Engr—Sept. 8, 1906. No. 79229 A.

Gas Power.

The Municipal Electric Station at Schwerin Mecklenburg (Das Stadtische Elektrizitätswerk in Schwerin i. M.). W. Schirmacher. A detailed description of the plant, there being two 330 horse power, two-cycle gas engines of Körting design, with suction producers to drive the dynamos. 3000 w. Elektrotech Zeitschr—Aug. 23, 1906. No. 79353 B.

Gas Producers.

Balanced Draft Gas Producer Furnace as Applied to Steam Boilers. Embury M'Lean. Abstract of a paper read before the Brooklyn Engrs. Club. Illustrated description. 2000 w. Ir Age—Sept. 13, 1906. No. 79154.

Producer Gas and Its Uses. W. H. Waddingham. Explains this system of gas making and some of its applications, giving the leading types of engines used, etc. 6 plates. 4000 w. Trans N E Coast Inst of Engrs & Shipbldrs—Aug., 1906. No. 79255 D.

Oil Engines.

Notes on Some Oil Engine Tests. Reports a series of tests made on an oil-engine driving, through an intermediary belt, a continuous-current dynamo in order to determine the behavior and efficiency of the engine at various loads. 1700 w. Elec Engr, Lond—Aug. 31, 1906. No. 79125 A.

Reciprocating Cylinder.

James' 4-Cycle Combustion Engine with Reciprocating Cylinder. Illustrations, showing an arrangement patented by T. S. James, the object being to secure more successful expulsion of the products of combustion during the exhaust stroke. 500 w. Mech Engr—Sept. 15, 1906. No. 79441 A.

HEATING AND COOLING.

Fans.

Theory and Computations for Propeller Fans (Theorie und Berechnung der Schraubenventilatoren). Dr. H. Lorenz. A mathematical examination of the principles and proportions of disc ventilating fans, with working formulas and tables. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 10, 1906. No. 79302 D.

Heating.

Electric Heating. Abstract of a paper by James I. Ayer, presented to the Nat. Elec. Lgt. Assn. Suggests ways of introducing electric heating into homes, and some of the useful applications. 2000 w. Elec Wld—Sept. 1, 1906. No. 78980.

Hot Water.

Hot Water Supplies to Towns. Thomas Parker. Remarks on methods of distribution, describing the network of the town of Muttabura, in Queensland, where an improved method has been introduced. 1000 w. Sci Am—Sept. 15, 1906. No. 79175.

Library.

Heating and Ventilating Equipment of the Carnegie Branch Library, No. 1, St. Louis, Mo. Illustrated description of a plant in which the air supplied is washed before its delivery to the rooms. 1400 w. Eng Rec—Sept. 1, 1906. No. 78928.

Roundhouse.

Gas Burning Heater with Fan System for Roundhouse. Illustrates and describes a modern and novel method adopted at Parsons, Kansas, for heating with natural gas. 1800 w. Ry Mas Mech —Sept., 1906. No. 79026.

Shops.

Heating and Ventilating Plant for the Shops of the Southern R. R. at Spencer, N. C. Describes an indirect steam heating system with fan blowers installed in a large new shop. Ills. 1000 w. Eng Rec—Sept. 8, 1906. No. 79035.

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Steam Heating.

Steam Heating in a Brooklyn Club Building. Illustrates and describes a steam-heating system with direct and indirect radiation and water heating for a swimming pool. 2500 w. Met Work—Sept. 8, 1906. No. 79023.

HYDRAULICS.

Centrifugal Pumps.

A New Centrifugal Pump Designed for Use with a Wide Range of Heads. Illustrates and describes the special features and reports tests. 800 w. Eng News—Sept. 27, 1906. No. 79472.

The Theory and Calculations for Centrifugal Fans and Pumps (Theorie und Berechnung der Zentrifugal Ventilatoren und Pumpen). Dr. H. Lorenz. Deriving formulas for the angles and form of vanes for runners for various speeds and discharges, both for fans and pumps. 3000 w. Zeitschr f d Gesamte Turbinenwesen—July 30, 1906. No. 79301 D.

Irrigation.

Irrigation in Western Canada. Lawrence J. Burpee. An illustrated article describing the extensive irrigation work in Alberta undertaken by the Canadian Pacific Railway. 3000 w. Sci Am Sup—Sept. 29, 1906. No. 79503.

Orifice.

Some Experiments on the Frictionless Orifice. Horace Judd and Roy S. King. Gives results of a series of experiments on frictionless orifices undertaken to determine stated points. Ills. 5500 w. Eng News—Sept. 27, 1906. No. 79471.

Piezometer.

See Mechanical Engineering, Measurement.

Pipe Lines.

Rifled Pipe for Conducting Heavy Crude Fuel Oil. John D. Isaacs. Illustrated description of this process, explaining the principle upon which it is based. 1200 w. Sci Am Sup—Sept. 15, 1906. No. 79178.

Plumbing.

Water: Its Composition, Filtration, Storage and Quantity Required for Domestic Use. Alfred E. Edwards. With a description of the plumbers' work, and appliances used in connection with its storage and distribution. Ills. 3800 w. Plumb & Dec—Sept. 1, 1906. No. 79103 A.

Pumping.

See Also Mining and Metallurgy, Mining.

Pumps.

Pumps for Gases, Petroleum and Chemicals (Pumpen für Gase, Erdöle, und Chemische Produkte). G. Hagemann. Describing especially plunger pumps with removable linings, valve-seats, etc., especially adapted for inspection and repair. 1500 w. Glasers Annalen—Sept. 1, 1906. No. 79335 D.

Victoria Falls.

The Victoria Falls as a Source of Power. William A. Carter. Illustrated description, and discussion of this scheme of power transmission for South Africa. 1000 w. Power—Oct., 1906. No. 79461 C.

MACHINE WORKS AND FOUNDRIES.

Annealing.

The Annealing of Non-Ferrous Metals. Illustrated description of the Bates-Peard continuous annealing furnace for non-ferrous metals. 3000 w. Ir & Coal Trds Rev—Sept. 7, 1906. No. 79244 A.

Blast Pressures.

A Plea for Lower Blast Pressures in Cupola and Air Furnaces. William H. Coleman. Read before the A. F. A. Convention. Discusses high and low blast pressures and the best practice under present conditions. 4000 w. Foundry—Sept., 1906. No. 79272.

Brass Melting.

The Electric Induction Furnace in Brass Melting. Explains the three classes of electric furnaces, describing the induction furnace and stating its advantages for melting metal. Ills. 2500 w. Brass Wld—Sept., 1906. No. 79494.

Castings.

Cleaning Castings with the Sand Blast. Illustrated review of machines designed in Germany for this purpose. 1000 w. Ir & Coal Trds Rev—Aug. 24, 1906. Serial. 1st part. No. 79021 A.

Modern Bell Casting. Dr. Alfred Gradenwitz. An illustrated article describing methods of casting and suspending bells. 1200 w. Sci Am—Sept. 15, 1906. No. 79176.

Cost Keeping.

The Cost-Stores System of a Modern Boiler-Manufacturing Plant. H. S. Knowlton. Describing the forms, methods, and practice of the Robb-Mumford Company. 3500 w. Engineering Magazine—Oct., 1906. No. 79385 B.

Cranes.

Derrick Cranes at the Berlin-Anhalt Machine Works, Berlin (Die Mastenkrananlage der Berlin-Anhaltischen Maschinenbau A. G. Berlin). K. Specht. Showing an arrangement of four electrically driven derrick cranes covering the entire yard of the works. Structural details are given. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 8, 1906. No. 79311 D.

Cylinders.

Molding Automobile Engine Cylinders. L. N. Perrault. Illustrates and describes the process as followed in the manufacturers' foundry at Waterbury, Conn. 3300 w. Ir Age—Sept. 13, 1906. No. 79151.

The Design and Construction of Cylinders. H. S. Brown. Discusses conditions affecting the truth of cylinders. 2000 w. Am Mach—Vol. 29. No. 36. No. 78973.

Drawing-Office.

Tracing, Lettering and Mounting. I. G. Bayley. This first of a series of articles deals especially with the essential materials of a drawing office, and directions for tracing. 2500 w. Mach, N Y —Sept., 1906. Serial. 1st part. No. 78964 C.

Electric Driving.

Electricity in Iron Works (Die Elektrizität im Huttenwesen). Hans Koch. A study of the generation and utilization of electricity in handling materials at the furnaces, driving rolls, etc., and in the general distribution and applications of power in iron and steel works. Serial. Part I. 2500 w. Aug. 18, 1906. No. 79338 D.

Fitting.

How Brasses Are Fitted. T. E. O'Donnell. Illustrates and describes the methods employed after lining up an engine. 2000 w. Engr, U S A—Sept. 15, 1906. No. 79293 C.

Foundry.

The Influence of Different Ore Mixtures on the Resultant Pig Iron from the Standpoint of the Foundry. W. A. Barrows, Jr. Read at the A. F. A. Convention. Gives reasons for some irons failing and some proving satisfactory. 2500 w. Foundry—Sept., 1906. No. 79277.

Grinding.

Selection and Use of Grinding Wheels. H. Darbyshire. Discusses the selection of wheels for a given material and shape of work and points relating to the use of the wheels. 3000 w. Am Mach—Vol. 29. No.36. No. 78970.

High-Speed Tools.

High-Speed Tools for Rapid Work in Turning Locomotive Driving-Wheel Tires. Illustrates and describes a 90-in. driving-wheel lathe and special tools of high-speed air-hardening steel. 600 w. Eng News—Sept. 13, 1906. No. 79173.

Laboratory.

A Steel Foundry Laboratory. Arthur Simonson. Gives information concerning the requirements of such a laboratory. Ills. 1500 w. Foundry—Sept., 1906. No. 79275.

Machine Tools.

Machine Tools at the Bavarian Jubilee Exposition, Nuremberg, 1906 (Die Werkzeugmaschinen auf der Bayerischen Jubiläums-Landesausstellung, Nürnberg. 1906). G. Schlesinger. A fully illustrated report upon iron and woodworking machinery at the exposition. Serial. Part I. 1200 w. Zeitschr d Ver Deutscher Ing—Aug. 18, 1906. No. 79305 D.

Molding.

Sweeping Cast Steel Slag Ladle Molds. H. J. McCaslin. An illustrated article describing the work. 1000 w. Foundry —Sept., 1906. No. 79273.

Molding Machine.

A Jobbing Molding Machine. Illustrated description of a new machine which belongs to the roll-over class, explaining its advantages. 1500 w. Ir Trd Rev—Sept. 13, 1906. No. 79179.

Sand Distributor and Revolving Sand Frame for Bonvillain Molding Machines. Illustrated description of these two devices. 1000 w. Am Mach—Vol. 29. No. 38. No. 79295.

Patterns.

Suggestions for Pattern Makers. H. J. McCaslin. Discusses the provisions for the molding and machining of castings, the pattern and core box work, etc. 2500 w. Foundry—Sept., 1906. No. 79274.

Pipe Flanging.

Modern Methods of Pipe Flanging by Machinery. Luther D. Lovekin. Describes a new method claimed to possess great advantages, especially in attaching flanges to copper pipe. Ills. 2500 w. Jour Am Soc of Nav Engrs—Aug., 1906. No. 79482 H.

Planers.

An Improved Planer Drive. W. H. Henley. Shows a new type of drive designed to largely reduce the waste of energy required. Ills. 600 w. Am Mach—Vol. 29. No. 36. No. 78972.

Planing.

Planing a Small Machine Part. H. P. Fairfield. An illustrated article showing the planer operations as performed on a cap box. 700 w. Mach, N Y—Sept., 1906. No. 78963 C.

Propeller.

Machining a Propeller. W. Burns. Describes the work. 1000 w. Am Mach —Vol. 29. No. 36. No. 78969.

Shops.

Lathe Works of Dean, Smith & Grace, Limited, Keighley, England. I. W. Chubb. An illustrated description of these shops and their equipment. 3000 w. Am Mach—Vol. 29. No. 36. No. 78968.

The Motor Workshops of Italy and the Lessons They Teach. A descriptive account, with illustrations, of notable features observed in these shops. 800 w. Auto Jour—Sept. 15, 1906. Serial. 1st part. No. 79435 A.

See also Railway Engineering, Permanent Way and Buildings.

MATERIALS OF CONSTRUCTION.

Brass.

Spring Brass and Bronze; Their Manufacture and Peculiarities. Erwin S. Sperry. An illustrated article considering the qualities necessary in a

spring metal, method of making spring wire, and related matters. 4500 w. Brass Wld—Aug., 1906. No. 79492.

The Effect of Sulphur on Brass. Erwin S. Sperry. A report of experimental investigations with results. 900 w. Brass Wld—Sept., 1906. No. 79495.

Cast Iron.

Malleable Cast Iron. G. A. Akerlind. Abstract of a paper read before the Scandinavian Tech. Soc. Reviews the manufacture of malleable cast iron and points in regard to its use as a material of construction. 2400 w. Mech Engr—Sept. 8, 1906. No. 79228 A.

Corrosion.

Electro-Positive Coatings for the Protection of Iron and Steel from Corrosion. Sherard Cowper-Coles. Read before the British Assn. Describes a new method for obtaining metallic coatings, by coating iron with zinc. Ills. 3500 w. Elec Engr, Lond—Aug. 31, 1906. No. 79124 A.

Lubricants.

Notes on Lubrication. William F. Parish, Jr. Abstract of a paper read before the Rugby Engng. Soc. Discusses the chemical composition, manufacture and testing of oils for lubrication, the practical application and results. General discussion. 5500 w. Elec Engr, Lond—Sept. 7, 1906. No. 79217 A.

Metals.

The Structure of Metals. Prof. J. A. Ewing. Read before the British Assn. for the Adv. of Science. Reviews recently acquired knowledge, by aid of the microscope, which gives engineers and physicists a better understanding of metals. 2000 w. Sci Am Sup—Sept. 29, 1906. No. 79502.

Overstrain.

Fatigue of Materials. Discusses the accident at Dowlais Cardiff Colliery in South Wales, April 28, and the cause of the breakage of the link in the chain holding the trams. 2000 w. Min Rept—Sept. 13, 1906. No. 79203.

Packings.

Hydraulic Packings. A. Reeder. Illustrates examples of packings and types of connections, giving explanations. 1700 w. Am Mach—Vol. 29. No. 36. No. 78974.

Steel.

Copper Alloy Steels (Sur les Aciers au Cuivre). Pierre Breuil. Data and results of drop tests on nicked bars, also torsion and hardness tests, and resistance to corrosion. 1500 w. Comptes Rendus—Aug. 27, 1906. No. 79330 D.

MEASUREMENT.

Calorimeter.

Notes on the Calibration of a Fuel Calorimeter. C. J. Evans. Explains the calibration of an instrument on the Thomson principle. 900 w. Engng—Aug. 31, 1906. No. 79141 A.

Dynamometer.

A New Absorption Dynamometer. Illustrates and describes a portable measuring brake that can be applied instantly to any size engine or motor, by means of which the power absorbed can be accurately measured. The Sellers' dynamometer. 700 w. Prac Engr—Sept. 14, 1906. No. 79439 A.

Flow.

Flow of Air and Other Gases, with Special Reference to Small Pressure Differences. Sanford A. Moss. Gives a collection of simplified and general formulas for velocity and discharge, with insructions for use. 4000 w. Am Mach—Vol. 29. No. 38. Serial. 1st part. No. 79294.

Piezometer.

A Direct Reading Nozzle Piezometer. F. B. Sanborn. Illustrates and describes a device for measuring the pressure and quantity of water that is being delivered by a fire stream or other flowing jet. 1000 w. Eng News—Sept. 13, 1906. No. 79168.

Strains.

Apparatus for the Study of Strains in Transparent Bodies by Polarised Light (Einrichtung für Versuche an Beanspruchten Durchsichtigen Körpern in Polarisiertem Licht). Otto Hönigsberg. With illustrations of apparatus for subjecting bodies of various shapes to stress while under visual inspection. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 31, 1906. No. 79329 D.

Stresses in a Rod Subjected to Combined Tension and Bending (Ein Fall des Eingespannten auf Zug und Biegung Beanspruchten Stabes). Ivan Arnovlevic. A mathematical discussion showing the applicability of hyperbolic functions to problems of this nature. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 24, 1906. No. 79328 D.

The Visibility of Neutral Planes in Strained Bodies (Ueber Direkte Sichtbarmachung der Neutralen Schichten an Beanspruchten Körpern). H. Siedentopf. Illustrating the application of polarized light to the observation of the internal distribution of strains in stressed bodies. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 17, 1906. No. 79326 D.

Testing.

Methods of Testing Metals by Alternate Strains and Thermic Treatment of Steels to Increase Their Resistance. James E. Howard. Abstract of a discussion before the Brussels Congress of the International Assn. for Testing Materials. 2000 w. Eng Rec—Sept. 22, 1906. No. 79433.

The Measuring Box as a Pressure Indicator (Die Messdose als Kraftmesser).

We supply copies of these articles. See page 319.

A. Martens. Describing the use of a closed vessel with flexible diaphragm for use in indicating the pressures employed in testing machines. 1800 w. Zeitschr d Ver Deutscher Ing—Aug. 18, 1906. No. 79306 D.

POWER AND TRANSMISSION.

Bearings.

Friction and Lubrication. Prof. G. F. Charnock. Lectures before the Bradford Engng. Soc. A study of the laws of friction and scientific methods of lubrication, especially considering the friction of bearings for shafting and machinery. Ills. 2000 w. Mech Engr—Aug. 25, 1906. Serial. 1st part. No. 78995 A.

Belts.

The Care of Belts. C J. Morrison. Gives simple rules for the care of belts. Ills. 1200 w. Am Mach—Vol. 29. No. 36. No. 78971.

Conveyors.

A Novel Cableway System of Coal Storage. Illustrated description of a new plant at Fall River, Mass., having a capacity of 20,000 tons, and the special type of cableway installed. 1500 w. Eng Rec—Sept. 15, 1906. No. 79163.

Recent American Improvements in Conveyors (Neuerungen im Amerikanischen Transportmaschinenbau). Georg von Hanffstengel. An illustrated review of improvements in bucket and belt conveyors and similar appliances, with especial reference to American practice. Serial. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 25, 1906. No. 79307 D.

Unloading-Bridges at Emden Outer Harbor. Illustrates and describes two electrically driven loading and unloading travelling bridges, for the rapid handling of coal, iron ores, and other goods in bulk. 900 w. Engng—Aug. 24, 1906. No. 79010 A.

Costs.

The Comparative Cost of Steam Engines, Steam Turbines, and Gas Engines for Works Driving. Reviews the comparative cost tables given by W. Schömburg in *Elektrotechnische Zeitschrift*. Ills. 1500 w. Elec Rev, Lond—Sept. 7, 1906. No. 79221 A.

Cranes.

Locomotive Cranes. Percy R. Allen. An illustrated article discussing cranes of British and Continental make. 3000 w. Cassier's Mag—Sept., 1906. No. 79250 B.

Hoisting.

Steam Consumption of a Modern Hoisting Plant. S. Powell, Jr. Reports a test made to determine the average rate of steam consumption of a modern high-class direct steam-driven hoisting apparatus under ordinary working conditions, when hoisting ore from a vertical deep-level shaft. 2000 w. Eng & Min Jour—Sept. 15, 1906. No. 79185.

Hotel Plant.

Power Plant of the Hotel St. Regis, New York. Illustrates and describes a very complete modern plant installed for service in a high-class hotel. 3000 w. Eng Rec—Sept. 8, 1906. No. 79034.

Mechanical Plant.

Mechanical Plant of the First National Bank Building, Chicago. Illustrated detailed description of a plant to serve a 16-story steel-cage office building. It will furnish electricity for power and lighting, elevator installation for operating 22 elevators, a refrigerating plant, and an extensive heating and ventilating equipment. 3000 w. Eng Rec—Sept. 22, 1906. No. 79427.

Power Plants.

Power Generation and Utilization in Mining and Metallurgical Plants (Kraftgewinnung und Kraftvenwertung in Berg und Hüttenwerken). Dr. H. Hoffmann. Discussing gas power driving electric transmission, and modern methods of utilizing power in mining operations. Serial. Part. I. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 1, 1906. No. 79308 D.

The Planning and Construction of the Power Plant. A. E. Dixon. The third paper discusses the actual machinery of steam generation; boilers, stokers, and chimneys, with numerous illustrations from the best modern practice. 5000 w. Engineering Magazine—Oct., 1906. No. 79386 B.

STEAM ENGINEERING.

Auxiliary Plant.

The Steam Power Plant at Nötsch (Die Dampfkraft anlage in Nötsch). Otto Neuburger. A description of the steam plant installed as an auxiliary to the hydraulic station of the lead mines at Nötsch in southern Austria, near Villach. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 11, 1906. No. 79337 D.

Boilers.

See Railway Engineering, Motive Power.

Chimneys.

See Civil Engineering, Construction.

Corrosion.

The Preservation of Surface Condenser Tubes in Plants Using Salt or Contaminated Water Circulation. W. W. Churchill. Read before the Am. Assn. for the Adv. of Science. Reports investigations made with a view of discovering a method of protection. 3000 w. Power—Oct., 1906. No. 79460 C.

Costs.

See Mechanical Engineering, Power and Transmission.

We supply copies of these articles. See page 319.

Engines.

Some Features of the Corliss Engine. W. H. Wakeman. Describes some features of these engines and some of the more important changes that have been made. Ills. 2300 w. Power—Oct., 1906. No. 79462 C.

Three-Cylinder Vertical Engine for Tyre Mills. Illustrations, with brief description of an engine designed especially for driving tyre and disc mills. 350 w. Engng—Sept. 14, 1906. No. 79450 A.

Feed Pumps.

Capacity of Duplex Boiler Feed Pumps. N. A. Carle. Gives a chart for selecting the size and number of duplex boiler feed pumps, operating at various piston speeds, explaining its use. 600 w. Power—Oct., 1906. No. 79463 C.

Feed-Water.

Feed-water Purification. R. T. Strohm. Considers the reasons for purifying feed-water and the methods. 2000 w. Elec Wld—Sept. 1, 1906. No. 78984.

Oil Extraction. A. B. Willets. Improvements in methods of extracting oil from feed-water for marine boilers. 1500 w. Ir Age—Sept. 13, 1906. No. 79152.

Fuels.

Fuels and Combustion. Sanford A. Moss. A condensed outline of the fundamental principles underlying the general subject of solid, liquid and gaseous fuels and their combustion. 4000 w. Power—Oct., 1906. Serial. 1st part. No. 79464 C.

Fuel, Water and Gas Analysis for Steam Users. John B. C. Kershaw. The present number considers natural and artificial fuels; their origin, composition and methods of sampling. 2800 w. Elec Rev, N Y—Sept. 8, 1906. Serial. 1st part. No. 79053.

How Should Steam Coal Be Purchased? William M. Booth. Gives replies from prominent engineers, superintendents, purchasers, etc., in regard to methods of buying coal, and discusses the subject generally. 3500 w. Eng Rec—Sept. 22, 1906. No. 79430.

Notes on the Burning of Small Anthracite Coal. E. H. Peabody. Discusses special features of the problem of successful firing with buckwheat coals. 1800 w. Elec Wld—Sept. 1, 1906. No. 78983.

Regulation of the Duration of Combustion. Byron Eldred. On flame regulation and its application to several arts. 3300 w. Jour Fr Inst—Sept., 1906. No. 79262 D.

The Burning of Cheap Fuels. Discusses the need of cheaper production of electrical energy, considering especially boiler-room economy. The present article deals with the burning of anthracite coals known as buckwheats. 2200 w. Elec Wld—Sept. 1, 1906. Serial. 1st part. No. 78982.

Marine Engines.

See Marine and Naval Engineering.

Piping.

The Arrangement of High-Pressure Piping (Ueber Befestigung Lagerung, und Kompensation von Hochdruckrohrleitungen). Discussing especially the methods of securing high-pressure steam pipes so as to provide for expansion and contraction. 2000 w. Glückauf—Sept. 8, 1906. No. 79343 D.

Steam Flow.

How Elastic Steam Lines Are Polarized. W. H. Booth. Explains the conditions essential to the best efficiency of steam turbines. 1200 w. Elec Rev, Lond—Sept. 7, 1906. No. 79220 A.

Thermodynamics.

The Second Law of Thermodynamics; Its Basis in Intuition and Common Sense. William S. Franklin. An explanation of what the law implies and its wide application. 3000 w. Elec Rev, N Y—Sept. 8, 1906. No. 79047.

Turbines.

A Chat About Steam Turbines. E. Austin. Considers turbines constructed on the Parsons' principle, dealing, in the present article, with the starting of the turbine for the first time, and the question of governing. 4000 w. Elec Rev, Lond—Sept 14, 1906. Serial. 1st part. No. 79446 A.

Recent Advances in Steam-Turbines, Land and Marine. Gerald Stoney. Read before the British Assn. On the development of the Parsons steam-turbine. Short discussion. 3800 w. Elec Engr, Lond—Aug. 24, 1906. No. 78998 A.

Steam-Turbine for Driving Cotton Machinery. Illustrated description of the plant at the Sladen Wood Mills, near Manchester, England, where a steam-turbine, arranged for rope transmission, is driving a weaving-shed containing 750 looms. 2200 w. Engng—Sept. 7, 1906. No. 79234 A.

The Construction of Steam Turbines by the General Electric Company, Berlin (Der Dampfturbinenbau der Allgemeinen Elektricitäts-Gesellschaft, Berlin). O. Lasche. A very fully illustrated description of the shops of the A. E. G., showing the detailed operations of building the Curtis turbine in Germany. Two articles. 10000 w. Zeitschr d Ver Deutscher Ing—Aug. 18, 25, 1906. No. 79304 each D.

The Use of Interheaters in Steam Turbine Plants of Various Sizes (Der Nutzen der Zwischenheizung bei Turbinenanlagen verschiedener Grösse). J. Nadrowski. With tables showing the economy effected in a number of actual Installations using the Knorring-Nadrowski system of interheaters and reheaters. 4000 w. Zeitschr f d Gesamte

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Turbinenwesen—Aug. 20, 1906. No. 79303 D.

See Also Marine and Naval Engineering.

Valve Setting.

Setting the Valves of the Fleming Four-Valve Engine. Thomas Hall. Directions, with illustrations, tables, etc. 2500 w. Power—Oct., 1906. No. 79458 C.

MISCELLANY.

Aeronautics.

The Wellman Expedition to the Pole in a Dirigible Balloon (Au Pole Nord en Ballon Dirigeable. L'Expedition Wellman). Lt. Col. G. Espitallier. A description of the balloon, automobile sledge, and apparatus, with an abstract of the computations of sustaining power and resistance. 4000 w. Génie Civil—Aug. 18, 1906. No. 79316 D.

Agriculture.

Clearing New Land. Franklin Williams, Jr. Illustrates and describes methods of pulling stumps by mechanical means in the present number. 4800 w. Sci Am Sup—Sept. 15, 1906. Serial. 1st part. No. 79177.

Air Pressure.

Variation in Atmospheric Pressure with Altitude. D. W. Hering. Explains how to determine the variation in atmospheric pressure with varying elevation, the changes of temperature with elevation, and the effect on the efficiency of compressors. 2000 w. Compressed Air—Sept., 1906. No. 79257.

Liquid Air.

A Novel Process of Liquefying Air and Separating Oxygen. Dr. Alfred Gradenwitz. Illustrates and describes the Claude Liquid Air Apparatus, and discusses some of the industrial possibilities. 1200 w. Prac Engr—Aug. 24, 1906. No. 78991 A.

Wind Shield.

A Novel Wind Shield. Joseph Eysséric. Translated from *La Science au XXme Siècle*. Illustrated description of a shield useful on bridge of a ship, in railway signal towers, on locomotives, and on automobiles. 1000 w. Sci Am Sup—Sept. 29, 1906. No. 79506.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Anthracite Coal Mining in Colorado. R. M. Hosea. An illustrated article describing the mines in operation, and showing why anthracite coal costs more than soft coal. 2000 w. Eng & Min Jour—Sept. 1, 1906. No. 78940.

Beehive Ovens.

Beehive Oven Construction. Howard N. Eavenson. Plans and details showing modern practice in the Connellsville and Pocahontas regions. 3000 w. Mines & Min—Sept., 1906. No. 78917 C.

Coalfield.

The Forest of Dean Coalfield. Historical account and description of the British mining field. 2000 w. Ir & Coal Trds Rev—Aug. 24, 1906. No. 79020 A.

Hungary.

The Zyltal Mines of the Salgo-Tarjan Coal Mining Company (Die Zsyltaler Gruben der Salgo-Tarjaner Steinkohlen Bergbau Aktiengesellschaft). Johann Adriecs & Aladar Blascheck. An illustrated account of the geology and workings of an important coal mining district in Hungary; with statistics of the output. Serial. Part I. 3000 w. Oesterr Zeitschr f Berg u Huttenwesen—Sept. 8, 1906. No. 79340 D.

Indiana.

Improvements in Indiana Coal Mines. James Epperson. Extracts from the annual report for 1905, concerning improvements made by numerous companies, aggregating large sums of money. 1500 w. Min Wld—Sept. 1, 1906. No. 78948.

Peat.

Peat as Fuel in the United States in 1905. Marius R. Campbell. Condensed from advance pages of Mineral Resources of the U. S. Reports the production, and tests made of both natural and machine peat. 1500 w. Eng News—Sept. 6, 1906. No. 79093.

Utah.

The Utah Coal Fields of the Wasatch, Near Grass Creek and Weber Cañon. Prof. Arthur Lakes. Illustrated description of the thick veins of lignitic coal with numerous faults. 1600 w. Mines & Min—Sept., 1906. No. 78915 C.

Westphalia.

The Coal Measures of the Bochum District between Dortmund and Camen (Das Flozfuhrende Steinkohlengebirge in der Bochumer Mulde zwischen Dortmund und Camen). Heinrich Meyer. A general geological study of the district, with especial reference to the coal meas-

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ures. Maps. 8000 w. 3 plates. Glückauf—Sept. 8, 1906. No. 79342.

COPPER.

Analysis.

The Estimation of Copper in Ore and Matte. O. H. Packer. Gives detailed description of the aluminum-strip-cyanide method for determining copper at the mine or smelter. 2000 w. Min & Sci Pr—Sept. 1, 1906. No. 79071.

British Columbia.

Copper Deposits of Eschelon Mountain, B. C. Horace F. Evans. Describes the occurrence, topography, etc., and gives information concerning conditions, and the development work. 1800 w. Min Wld—Sept. 8, 1906. No. 79046.

The Granby Mine, British Columbia. An illustrated description of this low-grade copper property and its working. 1200 w. Eng & Min Jour—Sept. 8, 1906. No. 79058.

Chile.

The Metallurgy of Copper in Chile. A. Gmehling. Abstract from Oester. Zeit. Describes the processes used in roasting of copper matte, the utilization of the escaping gases for the production of sulphuric acid, and the extraction of copper from low-grade ores by the acid thus produced. 2800 w. Eng & Min Jour—Sept. 8, 1906. No. 79061.

Converter.

Copper Converter Melting Its Own Matte. E. Jacobs. Describes the operation of a copper converter under unusual conditions. 5000 w. Eng & Min Jour—Sept. 8, 1906. No. 79057.

Drilling.

Drilling Practice in the Lake Superior Copper Mines. W. R. Crane. Describes the practice giving tabulated data of results obtained. 900 w. Eng & Min Jour—Sept. 8, 1906, No. 79056.

New Mexico.

The Burro Mountain Copper District. S. S. Lang. A description of the mining operations in this district in Grant Co., N. M., the occurrence of the ore, etc. 1200 w. Eng & Min Jour—Sept. 1, 1906. No. 78938.

Output.

The World's Copper Output for the Past Twenty-five Years. John B. C. Kershaw. Gives information relating to the output of raw material by the twelve leading copper-producing countries during the last twenty-five years. 3500 w. Cassier's Mag—Sept., 1906. No. 79253 B.

Pacific Coast.

Observations Relative to the Occurrence of Copper Ore on the Pacific Coast. William M. Brewer. An outline of the character and extent of the deposits on Vancouver Island and other portions of the Pacific Coast. 4000 w. B C Min Rec—Aug., 1906. No. 79489 B.

Peru.

The Copper Deposits of Ica and Nazca, Peru. Frederick G. Fuchs. Abstract translation from *Boletin del Cuerpo de Ingenieros de Minos del Peru.* Gives a résumé of observations made in the copper-bearing regions, and a description of the deposits. 1500 w. Min Jour—Sept. 1, 1904. No. 79134 A.

Smelting.

The Cost of Smelting Copper Ore. G. F. Beardsley. Information intended for mining men who may be trying to figure out the costs of ore treatment by blast-furnace methods. 1500 w. Eng & Min Jour—Sept. 1, 1906. No. 78939.

Utah.

The Utah Copper Company's Mine and Mills. An illustrated description of the mines, mining system, and method of milling. The caving system of mining is used. 3000 w. Eng & Min Jour—Sept. 8, 1906. No. 79055.

GOLD AND SILVER.

Alaska.

Mining in Ketchikan District, Alaska. William M. Brewer. Reviews the past history of this district, and explains present conditions. 2000 w. Eng & Min Jour—Sept. 8, 1906. No. 79059.

Australasia.

Gold Mining Industry of Australasia. F. S. Mance. Gives a comparative statement of the yield for 1905 and 1906, with remarks. 900 w. Eng & Min Jour—Sept. 1, 1906. No. 78936.

Brazil.

Matto Grosso, Brazil. Armando Brandenburg. Describes this state, and the deposits of gold, and of iron ore. 1200 w. Eng & Min Jour—Sept. 1, 1906. No. 78933.

Clarifying.

Notes on the Use of the Filter Press for Clarifying Solutions. S. J. Truscott and A. Yates. Reports the utilization of two Johnson presses with beneficial effect. 700 w. Jour Chem, Met, & Min Soc of S Africa—July, 1906. No. 79118 E.

Colombia.

Quartz Mining in Colombia. F. F. Sharpless. An illustrated article describing conditions and methods of mining. 2000 w. Eng & Min Jour—Sept. 15, 1906. No. 79184.

Colorado.

Mills and Milling Practices at Telluride, Colorado. The bulk of the tonnage mined is a gold and silver bearing quartz and sulphide, adapted for treatment by amalgamation, concentration or cyanidation. Describes the mills, their equipment and operation. Ills. 2000 w. Min Rept—Sept. 20, 1906. No. 79419.

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The Gold Prince Mill. H. J. Baron. Illustrated description of a new 500-ton mill in the San Juan region, Colorado. 1200 w. Min Rept—Aug. 30, 1906. No. 78941.

Cyaniding.

Cyanide Notes. E. A. H. Tays. Gives facts learned by experience in regard to successful cyaniding. 1400 w. Min & Sci Pr—Sept. 1, 1906. No. 79070.

Cyanide Practice with the Moore Filter. R. Gilman Brown. Describes a plant brought to successful operation during 1904-5. 2800 w. Min & Sci Pr—Sept. 1, 1906. Serial. 1st part. No. 79068.

Cyaniding in Mexico. J. Leslie Mannell. Reports the extent to which cyanide has been applied in the treatment of gold, silver and copper ores. 1000 w. Min Wld—Sept. 15, 1906. No. 79211.

See Electrical Engineering, Electrochemistry.

Gold Discovery.

Reported Finding of Gold in the Peace River Country. An illustrated report of a discovery in Canada which promises to be of importance. 4500 w. B C Min Rec—Aug., 1906. No. 79491 B.

Guanajuato.

A Metallurgical Revolution in Guanajuato. Joseph W. Richards. An illustrated article giving extracts from an address by Hon. Dwight Furness, summarizing the present metallurgical situation, and describing the revolution taking place from the patio to the cyanide process for the extraction of gold and silver. 2800 w. Elec Chem & Met Ind—Sept., 1906. No. 79200 C.

Hydraulic Mining.

A Hydraulic Mine in California. D'Arcy Weatherbe Illustrated description of the Spring Valley mine, in Butte Co. 1200 w. Min & Sci Pr—Sept. 8, 1906. No. 79205.

Leasing.

Leasing at Goldfield, Nevada. Claude T. Rice. An account of the ore bodies discovered by leasers and the values recovered. Ills. 2000 w. Eng & Min Jour—Sept. 15, 1906. No. 79183.

Milling.

Milling Plants of Summit County, Colorado. Describes mills for the concentration and separation of zinciferous ores and also of other ores. Ills. 1200 w. Min Rept—Sept. 6, 1906. No. 79064.

Preesnt Milling Conditions in the Cripple Creek District, Colorado. G. E. Wolcott. A statement of present conditions not altogether encouraging. 900 w. Min Rept—Sept. 6, 1906. No. 79063.

Mine Accounting.

Mine Accounting at Mineville, N. Y. A. E. Hodgkins. An explanation of the methods used. 2200 w. Eng & Min Jour—Sept. 22, 1905. No. 79410.

Nevada.

The Bullfrog Mining District, Nevada. Claude T. Rice. An illustrated description of this district and its development. It has large veins of a good milling grade of gold ore. 1800 w. Eng & Min Jour—Sept. 22, 1906. No. 79411.

New Zealand.

The First Gold Discoveries in New Zealand. R. A. Loughnan. An interesting account of the early discoveries and mining development. 6000 w. N Z Mines Rec—July 16, 1906. Serial. 1st part. No. 78985 B.

Nova Scotia.

Gold Lodes of Nova Scotia. H. J. Baron. Notes describing the saddle veins and their working, the vertical fissures, and other deposits, and some of the mining properties. Ills. 2500 w. Min Rept—Sept. 20, 1906. No. 79418.

Placers.

Breckenridge, Colorado. James W. Neill. An illustrated description of methods of placer mining. 1500 w. Min & Sci Pr—Sept. 8, 1906. No. 79204.

Placer Mining in Colombia. F. F. Sharpless. An illustrated article giving information concerning the production in past and present time, and related matters of interest. 2500 w. Eng & Min Jour—Sept. 1, 1906. No. 78937.

Rand.

Rand Metallurgical Practice and Recent Innovations. G. A. and H. S. Denny. A description of the Meyer & Charlton plant and its working. The object of the plant was to secure the ordinary operations of the decantation system by simple and costless processes depending on gravity. Plates. 40800 w. Jour S African Assn of Engrs—June, 1906. No. 79121 F.

Screening.

Report of Sub-Committee on the Standardization of Battery Screening. 2000 w. Jour Chem, Met, & Min Soc of S Africa (Supplement)—June, 1906. No. 79120 E.

Slimes.

Proposed Process for Treatment of Zinc Gold Slimes before Smelting. Charles E. Meyer. Explains a new process involving a precipitation and resolution in a reagent instead of simple solution by means of an acid. Gives results obtained by experiments. 2500 w. Jour Chem, Met, & Min Soc of S Africa—June, 1906. No. 79116 E.

Transylvania.

Mining in Transylvania. Ernest Levy. An illustrated article describing the geology and reporting concerning the paying gold mines. 1500 w. Min & Sci Pr—Sept. 1, 1906. No. 79067.

Tube-Mills.

Tube-Mill Practice. Discussion of W.

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R. Dowling's paper on this subject. 5000 w. Jour Chem, Met, & Min Soc of S Africa—June, 1906. No. 79117 E.

Victoria.

Victorian Auriferous Occurrences. Prof. T. S. Hart. An explanation of their mineralogical character. 4500 w. Aust Min Stand—July 25, Aug. 1, 1906. Serial. 2 parts. No. 78988 each B.

Volatilization Process.

The Application of the Pohle-Croasdale Process. O. H. Fairchild. Describes the new plant at Mayer, Arizona, which is the first attempt on a commercial scale to employ this volatilization process. Ills. 2000 w. Min & Sci Pr—Sept. 1, 1906. No. 79069.

IRON AND STEEL.

Billet Shears.

Billet Shears for Rolling-Mills. Illustrated descriptions of recent examples of such machines, used in German rolling-mills. 800 w. Engng—Sept. 7, 1906. No. 79233 A.

Census Report.

Census Report on Rolled Iron and Steel. Leading features of this report. 5000 w. Eng & Min Jour—Sept. 8, 1906. No. 79062.

Dry Air Blast.

The Gayley Dry Blast Process. Prof. B. Osann. Condensed from *Stahl und Eisen*. Describes a proposed German modification of this process. 4800 w. Ir Age—Sept. 27, 1906. No. 79465.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Hematite.

Hematite Mining in New York. Robert B. Brinsmade. Descriptive account of red hematite deposits in St. Lawrence Co., their geology, history, methods of mining, etc. Ills. 3000 w. Eng & Min Jour—Sept. 15, 1906. Serial. 1st part. No. 79186.

Iron Works.

The Lowmoor Iron Works. An illustrated article giving particulars regarding these works. 5000 w. Ir & Coal Trds Rev—Aug. 24, 1906. No. 79022 A.

The Minnequa Works of the Colorado Fuel and Iron Company. Lawrence Lewis. Illustrated descriptions of the blast-furnaces and other departments of these extensive works at Pueblo, Colorado. 2400 w. Sci Am—Sept. 22, 1906. No. 79291.

Open Hearth.

The Manufacture of Steel in Open-Hearth Furnaces. Horace Allen. Describes the principal parts of the apparatus, and briefly considers several processes for the production of steel. Ills. 1000 w. Mech Engr—Sept. 1, 1906. No. 79123 A.

Separation.

The Wet Separation of Iron Ores. Walter J. May. Suggestions for the cleaning of low grade ores. 1000 w. Prac Engr—Sept. 7, 1906. No. 79227 A.

Smelting.

An Iron Smelters' Village in India. C. M. Weld. Describes a type of present day Indian iron smelting. Ills. 2500 w. Ir Age—Sept. 13, 1906. No. 79153.

Sulphur.

The Determination of Sulphur in Iron (Zur Bestimmung des Schwefels im Eisen). Wilhelm Schulte. A review of the practice of various iron-works laboratories, with notes and apparatus illustrating the author's methods. 4000 w Stahl u Eisen—Aug. 15, 1906. No. 79-368 D.

Vermillion.

The Steel Corporation's Vermillion Mines. A report of the progress of these valuable iron mines in the Lake Superior district. 1500 w. Ir Age—Sept. 13, 1906. No. 79155.

MINING.

Air Blasts.

Stresses in the Country Rock as the Cause of Air Blasts in the Mines at Pribram, Bohemia. Hugo Stefan. Describes conditions in these mines which seem to justify the conclusion that the cause of explosions is due to pressure and stresses, and considers the preventive measures employed. 2500 w. Sch of Mines Qr—July, 1906. No. 79263 D.

British Columbia.

Blue Bell Mine and Pilot Bay Smelter, Kootenay Lake. E. Jacobs. Information concerning the early history, with notes of these enterprises as they are to-day. The ore is lead-zinc-silver. Ills. 4000 w. B C Min Rec—July, 1906. No. 78912 B.

Review of Present Condition of the Mining and Smelting Industries of British Columbia. E. Jacobs. A report of prosperous conditions, 1200 w. B C Min Rec—Aug., 1906. No. 79490 B.

Cascade Region.

International Geology of Cascade Region. Horace F. Evans. Presents geological information from reliable sources concerning the character of the region near the boundary of the United States on the western coast. 2500 w. Min Wld—Sept. 1, 1906. No. 78947.

Colorado.

Undeveloped Empire of Middle Park, Colo. Etienne A. Ritter. Map and brief description of a mining region crossed by the new railroad from Denver to Salt Lake City. 1400 w. Min Wld—Sept. 22, 1906. No. 79426.

Compressed Air.

Uses of Compressed Air in Coal Mines. J. L. Dixon. Read before the Coal Min. Inst. Calls attention to economies ren-

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dered possible by its use, and its application to safety stations in mines. 4500 w. Mines & Min—Sept., 1906. No. 78918 C.

Costs.

Notes on Underground Mining Costs. H. Fraser Roche. Considers the cost of stoping, shovelling and tramming, development, etc. 3500 w. Jour Chem, Met, & Min Soc of S Africa—July, 1906. No. 79119 E.

Dangers.

Imminent Mine Dangers. Hon. George Harrison. Abstracted from the Ohio Annual Report. Calls attention to the derangement of ventilation by electric haulage and its menace to the traveling ways. 1500 w. Mines & Min—Sept., 1906. No. 78916 C.

Deep Level.

Deep Level Shafts on the Rand. E. M. Weston. Comments based, in part, on personal experience. 2000 w. Aust Min Stand—Aug. 15, 1906. Serial. 1st part. No. 79488 B.

Deposits.

Economic Geology and Mineral Deposits. Francis C. Nicholas. Gives a general description and classification according to the various periods of development. 1500 w. Min Wld—Sept. 8, 1906. Serial. 1st part. No. 79045.

Disaster.

Official Report of the Courrières Explosion. Review of the final report of the Government Commission appointed to enquire into the manner by which the State engineers conducted rescue operations after the Courrières explosion. 1500 w. Col Guard—Aug. 24, 1906. No. 79008 A.

Electrical Machinery.

Electrical Machinery for Mines. George Farmer. Gives suggestions for safeguarding against fire and explosion, discussing the danger. 2200 w. Cassier's Mag—Sept., 1906. No. 79249 B.

Electric Machinery for the Operation of Mexican Mines. Charles V. Allen. The second and concluding article discusses especially the hoisting machinery of the El Oro mine, describing the operations at the Somera shaft, 1500 feet deep. 2500 w. Engineering Magazine—Oct., 1906. No. 79384 B.

Explosives.

Explosives in Coal Mines. Extracts from the last order issued from the Home Office, giving particulars of a number of explosives. 700 w. Col Guard—Sept. 7, 1906. No. 79231 A.

Germany.

The Distribution of Minerals in the Werden Mining District and its Environs (Die Mineralaüsfullung der Querverwerfungsspalten im Bergrevier Werden und einigen Angrenzenden Gebieten). H. E. Böker. An examination of the geology of Rhenish Prussia, with especial reference to its mining resources. Two articles. 10000 w. Glückauf—Aug. 18, 25, 1906. No. 79341, each D.

Haulage.

Haulage in Iron Mines of Alabama. W. R. Crane. Illustrates and describes the system in use in the hard iron-ore mines of the Birmingham district. 2000 w. Min & Sci Pr—Aug. 25, 1906. No. 78945.

Hoisting.

Electrical Mining Hoists. J. W. H. Hamilton. An illustrated description of the hoisting system devised by Carl Ilgner, chief engineer of the Austrian firm of Siemens-Schuckert-Werke. 2200 w. Eng & Min Jour—Sept. 22, 1906. No. 79412.

Recent Installations of Electric Winding Engines (Neuere Ausführungen von Elektrischen Fördermaschinen). Karl Ilgner. A well illustrated description of the installations of the Ilgner-Siemens-Schuckert system at Merklinde, Dortmund; at Karwin, Silesia; and at Witkowitz, Austria; showing good performance in deep shafts. Two articles. 5000 w. Elektrotech u Maschinenbau—Aug. 26, Sept. 2, 1906. No. 79362 each D.

Skip Hoisting. S. A. Worcester. An illustrated article explaining the advantages of the self-dumping skip for hoisting ore and waste rock, and comparing it with the cage. 1200 w. Eng & Min Jour—Sept. 1, 1906. No. 78934.

The Factor of Safety in Winding Ropes. J. A. Vaughan. Gives the principal points presented in a paper to the South African Assn. of Engrs. in 1904, entitled "An Investigation Regarding the Effect of Kinetic Shocks on Winding ropes in Vertical Shafts." 3000 w. Engr, Lond—Aug. 24, 1906. Serial. 1st part. No. 79015 A.

The Main Electric Winding Engine at the Coal Mines at Ligny-les-Aire (Die Elektrisch Betriebene Hauptschacht fördermaschine der Compagnie des Mines de Houille de Ligny-les-Aire). H. Damm. An illustrated account of the design and operation of electric winding machinery operating to a depth of 270 metres. 3500 w. Glückauf—Sept. 15 1906. No. 79344 D.

Madagascar.

Madagascar Mining. M. S. Stutchbury. Discusses the new law recently passed. 900 w. Eng & Min Jour—Sept. 8, 1906. No. 79054.

Mexico.

Brief Notes on Mining Before the Conquest. Eduardo Martinez Baca. 600 w. Min Wld—Sept. 15, 1906. No. 79209.

Mexico. Robert Thomas Hill. The first of a series of illustrated articles describing the physical features, geology,

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mines, ore deposits, and economic industries, and giving much information of interest. 2800 w. Min Wld—Sept. 22, 1906. Serial. 1st part. No. 79425.

Mining in Mexico: Past and Present. Historical review of the mining industry. 2800 w. Min Wld—Sept. 15, 1906. No. 79208.

Mining Law.

The Bituminous Mining Law of Pennsylvania. Charlton Dixon. Gives detailed suggestions for its improvement. Also editorial. 5500 w. Mines & Min—Sept., 1906. No. 78914 C.

Mining Plants.

The Erection and Working of Mining Plants. Discusses the economies and efficiencies that may be obtained in the practical working and equipping of such plants. 3500 w. Min Jour—Sept. 15, 1906. Serial. 1st part. No. 79448 A.

Nuggets.

How Nuggets May Be Made. Charles S. Palmer. Presents a theory that may explain the origin of nuggets of copper, silver, or gold. 1600 w. Min & Sci Pr—Sept. 15, 1906. No. 79421.

Ore Thawing.

A New Ore Thawing Plant. Illustrated description of a new kiln thawing equipment for thawing cars of frozen ore. 1000 w. Eng Rec—Sept. 15, 1906. No. 79158.

Pumping.

The Electric Pumping Plant at the Wilhelmina Coal Mine at Heerlen, Holland (Die Elektrisch Betriebene Abteufanlage auf Grube Wilhelmina der Holländischen Staatsminen-Verwaltung bei Heerlen, Holland). W. Philippi. A very complete description of the use of high-speed centrifugal pumps driven by three-phase motors. 5000 w. Elektrotech Zeitschr—Aug. 30, 1906. No. 79356 B.

Triple-Expansion Pumping-Engine; Wilge River Station, South Africa. Illustrated description of machinery installed in the pumping station in connection with the working of the Premier diamond mines, near Pretoria, Transvaal. 600 w. Engng—Aug. 31, 1906. No. 79138 A.

Rock Drills.

Models of Rock Drills at South Kensington. Describes some interesting models of rock-drilling and boring machinery recently added. 1200 w. Engr, Lond—Aug. 31, 1906. No. 79148 A.

Roasting.

The Conversion of Sulphide Ores to Sulphates by Roasting (Ueber Sulfatisierende Röstung der Sulfidischen Erze). Dr. Rudolf Vondracek. A study of the chemical reactions in the roasting of sulphide ores of various metals for the production of sulphates. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 25, 1906. No. 79339 D.

Safety.

Safety in Mining. Extracts from a paper by Messrs. Donald Macaulay and Lewis G. Irving, contributed to the Journal of the Chem., Met. & Min. Soc. of S. Africa. 8900 w. Can Min Rev—Sept., 1906. No. 79279 B.

Separation.

Magnetic Separation at Galena, Illinois. Describes a plant for the separation of low-grade zinc ores. 1000 w. Eng & Min Jour—Sept. 15, 1906. No. 79182.

Shafts.

Shaft Sinking. S. H. Dunshee. Suggestions of value in the sinking and construction of shafts, and of their operation. 2800 w. Min Rept—Sept. 20, 1906. No. 79417.

The Cementing of Shafts Sunk through Water Bearing Strata (La Cimentation Appliquée comme Moyen de Fonçage des Pints en Terrains Aquifères). H. Schmerber. An illustrated description of the method of pumping liquid cement behind the temporary lining, with details of actual shaft-sinking in France and Germany. Two articles. 4000 w. Génie Civil—Aug. 25, Sept. 1, 1906. No. 79319 each D.

Surveys.

A Quick Vertical-Shaft Survey. W. E. Downs. Explains a method long used by the writer in making quick and accurate surveys of various vertical shafts along the Mother Lode of California. 1000 w. Min & Sci Pr—Aug. 25, 1906. No. 78944.

Colliery Surveying and Office Methods. F. W. Parsons. This first of a series of articles considers methods of mine surveying in the United States. 2000 w. Eng & Min Jour—Sept. 8, 1906. Serial. 1st part. No. 79060.

Veins.

Thermal Activity in Its Relation to the Genesis of Certain Metalliferous Veins. Prof. James Park. Considers effects due to thermal solutions aided by steam and gases. 3300 w. N Z Mines Rec—July 16, 1906. Serial. 1st part. No. 78986 B.

Washington.

Coal, Iron and Metalliferous Resources of Kittitas County, Washington. Gives information from the reports of the U. S. Geological Survey. 1800 w. Min Rept—Sept. 6, 1906. No. 79066.

MISCELLANY.

Congress.

Metallurgy at the Congress of Applied Chemistry at Rome (La Métallurgie au Congrès de Chimie Appliquée de Rome). Léon Guillet. Abstracts of the reports from various countries, including the alloys of iron and of copper, and a brief note on miscellaneous products. Two articles. 4000 w. Génie Civil—Aug. 18, 25, 1906. No. 79317 each D.

We supply copies of these articles. See page 319.

Petroleum.

Petroleum in Japan. I. A. Stigand. A review of the oil industry, the oilfields, geology, etc. Ills. 2000 w. Jour Soc of Arts—Aug. 10, 1906. No. 79127 A.

Quicksilver.

The Reduction of Quicksilver. From Adv. Sheets from Mineral Resources of the U. S. Explains the methods of extraction in use. 1500 w. Min Rept—Aug. 30, 1906. No. 78943.

Tin.

Geology of Malay Tin-Fields. Ralph Stokes. Describes the deposits and geological features so far as known. Ills. 1800 w. Min Wld—Sept. 8, 1906. No. 79044.

Industrial Position of the Malay Tin Fields. Ralph Stokes. An illustrated article discussing the prospects of the future yield of these fields. 2500 w. Min Wld—Sept. 1, 1906. No. 78946.

Occurrence of Tin in the St. Austell District. R. H. Williams. A review of this district in Cornwall, England, describing the geological structure. 1200 w. Min Jour—Sept. 8, 1906. No. 79230 A.

The Tin Deposits of North and South Carolina. Frank L. Hess. A review of the present development and promise of the region, with illustrations of the existing workings. 3500 w. Engineering Magazine—Oct., 1906. No. 79382 B.

Tin-Mining in the Malay States. John Place. Gives information relating to the country and an account of tin-ore mining. Ills. 2000 w. Engng—Aug. 31, 1906. No. 79136 A.

Vanadium.

A New Occurrence of Vanadium in Peru. Foster Hewett. Preliminary notes concerning the deposit, containing vanadium, found near Cerro de Pasco. 1000 w. Eng & Min Jour—Sept. 1, 1906. No. 78932.

Zinc.

Kelly, New Mexico. Robert B. Brinsmade. An illustrated account of a zinc camp whose ores have been made available by modern metallurgical methods. 5000 w. Mines & Min—Sept., 1906. No. 78913 C.

Mining and Milling at Platteville, Wis. Illustrates and describes the zinc-lead mines of this district, with the exception of the Enterprise mine, which has been previously described. 1200 w. Eng & Min Jour—Sept. 22, 1906. No. 79413.

The Mineral Point Zinc Works. Illustrated description of a plant where sulphuric acid and zinc oxide are made; and where mixed concentrates of blende and marcasite are treated by magnetic separation, producing high grade zinc concentrate. 2200 w. Eng & Min Jour—Sept. 1, 1906. No. 78935.

Zinc Mining in Chihuahua. Leonard Worchester, Jr. A brief account of the zinc mining industry, reporting the prospects good. 700 w. Min Wld—Sept. 15, 1906. No. 79212.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Transportation.

The Canal and the Railroad from 1861 to 1865. From a paper by Emerson D. Fite, in the *Yale Review*. A review of the remarkable growth and prosperity of these transportation industries. 5400 w. R R Gaz—Sept. 14, 1906. No. 79194.

Wastes.

Economic Wastes in Transportation. W. Z. Ripley. From a paper in the *Pol. Sci. Qr.* Discusses certain results sure to follow the wide acceptance of the blanket rates, and wastes in transportation service, and the remedy. 8000 w. R R Gaz—Sept. 28, 1906. No. 79498.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Piping. Shows how ells and short bends interfere with the action of the brakes, and how they can produce disastrous results. 1200 w. Ry & Loc Engng—Sept., 1906. No. 78957 C.

Diagrams of K. Triples. Gives five diagrammatic drawings illustrating the operative positions of the K triple valve, with explanatory notes. 1000 w. Ry & Loc Engng—Sept., 1906. No. 78956 C.

Handling the Air Brake in Passenger Train Service. C. C. Farmer. Presented to the Convention of the Trav. Engrs.' Assn. Discusses the means of securing a comparatively uniform distribution of the brake power throughout a train. 2200 w. R R Gaz—Sept. 7, 1906. No. 79099.

Brakes.

The Westinghouse Electromagnetic Brake. Rudolf Braun. Translated from *Elektrische Bahnen und Betriebe*. Illustrates several types, giving information in regard to their action and conclusions from trials. Ills. 5500 w. Bul Int Ry Cong—Aug., 1906. No. 79281 E.

Cars.

Automobile and Horse Car. Illustrated description of a car for the transportation of automobiles, horses and carriages, for the express service of the Boston & Maine Railroad. 1200 w. Ry & Loc Engng—Sept., 1906. No. 78958 C.

Bogie Composite Lavatory Carriage

We supply copies of these articles. See page 319.

for the South-Eastern and Chatham Railway. Illustrated description. Plate. 700 w. Engng—Aug. 31, 1906. No. 79139 A.

Steel Car Equipment on the Long Island R. R. W. N. Smith. Illustrated detailed description of the Standard type of rolling equipment for the electric lines. 3500 w. Ry & Engng Rev—Sept. 1, 1906. No. 78960.

Crank Axles.

The Advantages of Crank Axles for Locomotives. W. F. Cleveland. An explanation of the conditions and the satisfactory change effected by the use of crank axles. 1000 w. Sci Am—Sept. 22, 1906. No. 79290.

Derailment.

Overturning of Locomotives. Rollo Appleyard. Discussion of the super-elevation of curves and its influence on derailment; explaining the Salisbury accident. 800 w. Mech Engr—Sept. 1, 1906. No. 79122 A.

Electrification.

Electrical Equipment of the West Shore. An account of the important work in progress between Utica and Syracuse, N. Y. Ills. 1500 w. Ry Age—Sept. 7, 1906. No. 79075.

Electric Traction on the Blankenese-Ohlsdorf Railway (Der Elektrische Betrieb der Bahn Blankenese-Ohlsdorf). G. Schimpff. A very complete account of the conversion from steam to electricity, of a local road near Hamburg. Two articles. 3 plates. 6000 w. Glasers Annalen—Sept. 1, 15, 1906. No. 79334, each D.

The Present Status of the Electrification of the New York Zone of the New York Central & Hudson River R. R. W. J. Wilgus. An illustrated article showing the progress made in these extensive improvements, and commenting on the problems that have had to be solved. 2000 w. Elec Rev, N Y—Sept. 8, 1906. No. 79048.

The Rotary Converter Substations and Electric Car Equipment of the Long Island Railroad. An illustrated article describing the substation buildings and their equipment, the train service, cars, etc. 6000 w. Eng News—Sept. 27, 1906. No. 79470.

Ward Leonard-Oerlikon Locomotives. Illustrates details of the Oerlikon system. Describes a locomotive carrying a converter for transforming the single-phase currents into direct currents. 1500 w. Elec Engr, Lond—Sept. 7, 1906. No. 79216 A.

The Single-Phase System in Steam Line Electrification and Electric Railway Development. Calvert Townley. Discusses the single-phase alternating current system and its value in the electrification of steam lines. 2500 w. Elec Rev, N Y—Sept. 8, 1906. No. 79049.

Fireboxes.

Repairs to Wide and Narrow Fireboxes. Information from an address by James F. De Voy regarding repairs to wide and narrow fireboxes, showing that in repairs the narrow firebox is the more economical, especially in high-speed locomotives. 1300 w. R R Gaz—Sept. 21, 1906. No. 79400.

Locomotive Boiler.

The Robert Water-Tube Locomotive Boiler. Illustrated description of a boiler exhibited at Milan. 1000 w. Engng—Aug. 24, 1906. No. 79011 A.

Locomotives.

Consolidation Locomotives with Allfree-Hubbell Cylinders and Valves. Describes a practical test made on two locomotives, identical in every respect except cylinders and valves, showing the effect on tonnage hauled and cost of operation due to the difference in the steam distribution. 1500 w. Am Engr & R R Jour—Sept., 1906. No. 78950 C.

Goods Locomotive for the Caledonian Railway. Illustration, diagram, and description. 500 w. Engng—Aug. 31, 1906. No. 79144 A.

Heavy Six-Wheel Switching Locomotive. Illustrated description of an engine for the Pittsburg & Lake Erie railroad, having a total weight of 176,500 lbs. 500 w. Am Engr & R R Jour—Sept., 1906. No. 78952 C.

Light Eight-Wheel Switching Locomotive. Illustrated description of switching engine for the East Tennessee & Western North Carolina Railroad. 500 w. Ry Age—Aug. 31, 1906. No. 78959.

Links in Locomotive Development. Gives three diagrammatic illustrations of typical Great Northern locomotives at successive periods in the history of that railway, together with details of their seating dimensions. 1000 w. Engr, Lond—Aug. 24, 1906. No. 79013 A.

Mallet Duplex Compound Freight Locomotives for the Great Northern Ry. Illustration, with description and general dimensions. 900 w. Eng News—Sept. 27, 1906. No. 79469.

Modern Locomotive Construction in Belgium. Remarks on the Milan exhibits of Belgian locomotives, and an illustrated description of the La Meuse four-cylinder engine and other types. 3500 w. Engr, Lond—Sept. 7, 1906. No. 79237 A.

New Tank Locomotives, London and Northwestern Railway. Illustrated description of a new type of tank engine. 600 w. Mech Engr—Aug. 25, 1906. No. 78992 A.

We supply copies of these articles. See page 319.

Pacific Type Passenger Locomotive. Illustrated detailed description of engines for the Norfolk & Western Railway. 1000 w. Am Engr & R R Jour—Sept., 1906. No. 78954 C.

Some Interesting Types of Locomotive Development. Illustrations, principal dimensions, and information relating to recent types put in service. 1800 w. Ry Mas Mech—Sept., 1906. No. 79025.

Tank Locomotive Fitted with Lentz Reversing Gear and Poppet Valves. Illustrated description of an engine exhibited at Milan, having the poppet valves placed horizontally, and a new type of reversing gear which dispenses with the link. 600 w. Ry Age—Sept. 14, 1906. No. 79195.

The Development of the de Glehn System Compound Locomotive in France. Charles S. Lake. An illustrated review covering a period of 15 years, from 1891 to 1906. 2000 w. Mech Engr—Sept. 15, 1906. Serial. 1st part. No. 79440 A.

The Lake Shore Four-Cylinder Simple Inspection Locomotive. Data and illustrated description. 1000 w. R R Gaz—Sept. 7, 1906. No. 79100.

Thirty years of Compound Locomotive Practice. Reviews the origin and history of the compound locomotive. Also editorial. 4500 w. Engr, Lond—Sept. 14, 1906. No. 79452 A.

Motor-Cars.

Railway Motor-Carriage (760-Millimeter Gauge); Milan Exhibition. Illustrated detailed description of two steam motor-carriages, representing types in use on Austrian railway lines. 800 w. Engng—Sept. 7, 1906. No. 79235 A.

Steam Motor Car. Illustrated detailed description of a car recently placed in operation on the Canadian Pacific Railway. 800 w. Am Engr & R R Jour—Sept., 1906. No. 78949 C.

Repairs.

Locomotive Repair Schedule. C. J. Morrison. Gives an erecting floor schedule for light, heavy, and general repairs in a shop operated by the gang method, explaining the system. 1500 w. Am Engr & R R Jour—Sept., 1906. No. 78951 C.

Rolling Stock.

Specification for Material Used in the Construction of Railway Rolling Stock. Deals with the important specifications just issued by the Engineering Standards Committee, considering axles in the present number. 1600 w. Ir & Coal Trds Rev—Sept. 7, 1906. Serial. 1st part. No. 79245 A.

Speed Indicator.

The Flamm Speed Indicator. Illustrated description of an apparatus designed to record automatically the speed of a locomotive attained throughout the run. 800 w. R R Gaz—Sept. 21, 1906. No. 79406.

Tender.

Locomotive Tender. Sections and description of a tender for the Chicago & Northwestern railway having a capacity for 7500 gals. of water and 10 tons of coal. 500 w. Am Engr & R R Jour—Sept., 1906. No. 78953 C.

NEW PROJECTS.

Canada.

Canadian Railways. Information in regard to new construction work, its cost, importance, legislation, etc. 1500 w. Engr, Lond—Aug. 31, 1906. No. 79147 A.

Construction.

Current Railway Construction. An account of the construction work in progress and proposed on English lines. 2000 w. Engng—Aug. 31, 1906. No. 79137 A.

Cut-Off.

The New Low-Grade Freight Line of the Erie R. R. An illustrated description of a heavy piece of railroad construction in Southeastern New York in connection with the extensive reconstruction and betterment-of-way work in progress. 2500 w. Eng Rec—Sept. 8, 1906. No. 79029.

Improvements.

Details of Construction of the Ossining Improvements on the New York Central R. R. The electrification of the metropolitan zone, and the completion of the four track system, made necessary extensive construction and reconstruction works which are illustrated and described. 2200 w. Eng Rec—Sept. 22, 1906. No. 79431.

The Eastern Railway of New Mexico (Atchison, Topeka & Santa Fé Railway System). Plans and description of the construction of a new line, connecting existing lines and providing a through route to the Pacific coast and Mexico. 1800 w. Eng News—Sept. 6, 1906. No. 79092.

Mexico.

Making a System of Mexican Railroads. Edward M. Conley. A review of railroads under construction and projected, and the changes in their management; the new terminal harbors, and extensive improvements. Map. 3300 w. Ry Age—Sept. 21, 1906. No. 79422.

Siberian.

Circum-Baikal Railway. Brief account of the great floating ferry first constructed for crossing this large lake, and the more recent construction of a line around the southern extremity of the lake. 1400 w. Engng—Aug. 31, 1906. No. 79143 A.

PERMANENT WAY AND BUILDINGS.

Coaling.

Mechanical Coaling Stations for Loco-

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motives (Installations de Chargement Mécanique du Charbon dans les Dépôts de Locomotives). Illustrating and describing Belgian, German, and American railroad coaling stations, with details of bins, conveyors, etc. 2000 w. 1 plate. Génie Civil—Aug. 11, 1906. No. 79313 D.

Gravel Washing.

The Lake Shore Gravel Ballast Washing Plants. Illustrates and describes plants in Indiana which are working satisfactorily and handling large quantities of material. 2000 w. R R Gaz—Sept. 14, 1906. No. 79190.

Location.

Some Tables and Other Data for Railway Locating Engineers. C. P. Howard. Gives tables in form so that calculations of cost can be made in the shortest possible time and with reasonable accuracy, with explanatory notes. 3500 w. Eng News—Sept. 13, 1906. No. 79167.

Rails.

Note on the Metal Screw Bushes for Strengthening Rail Fastenings, on the Thiollier System. Describes the method of putting in the bushes; the cost, results, resistance, etc., are discussed, and the applications considered. 3000 w. 6 tables & fig. Bul Int Ry Cong—Aug., 1906. No. 79280 E.

Roadbed.

A Concrete Roadbed for Railroads. Illustrated description of a design for a concrete roadbed using longitudinal timber supports for the rails, giving estimate of cost. 1100 w. Ry Age—Sept. 1, 1906. No. 79423.

Shops.

Angus Shops—Canadian Pacific Railway. First of a series of illustrated articles on the operation of the Angus shops. 4500 w. Ry Mas Mech—Sept., 1906. Serial. 1st part. No. 79024.

Organization and Construction Methods Used on the Ivorydale Shops of the C. H. & D. Plan, with detailed description of the methods employed. 2500 w. R R Gaz—Sept. 21, 1906. No. 79404.

Organization and Economy in the Railway Machine Shop. H. W. Jacobs. The second article of the series treats of the standardization of parts and tools, with illustrations of tools and their operation. 4000 w. Engineering Magazine—Oct., 1906. No. 79383 B.

Signalling.

The Forestier System of Templates for Automatic Signalling (Preparateur d'Itinéraire Système J. Forestier). R. Coupan. The successive connections for any given train are controlled by electric contacts placed in proper sequence on a template disc, avoiding accidents or delays. 3000 w. 1 plate. Génie Civil—Aug. 18, 1906. No. 79315 D.

Sleepers.

Automatic Sleeper Adzing and Boring Machine. Illustrates and describes a machine for dealing with large and heavy sleepers of any kind of wood, and is used for simultaneously adzing both ends and cross-cutting the sleeper to length, and boring four spike holes at each end. 600 w. Engng—Aug. 31, 1906. No. 79140 A.

Plant of the Ayer & Lord Tie Co., at Carbondale, Ill. R. E. Bright. Illustrated description of machinery and methods used for preserving wood railway ties. 1300 w. Engr, U S A. Sept. 15, 1906. No. 79292 C.

Terminals.

Freight Terminal Facilities at St. Louis. Information from an interesting report made by Robert Moore and Albert T. Perkins, concerning the freight facilities of St. Louis and what is needed to make them equal to the growing needs. 1200 w. R R Gaz—Sept. 21, 1906. No. 79405.

Progress of the New York Central & Hudson River R. R. Terminal Improvements in New York City. Brief illustrated article describing the progress in this great undertaking. 1000 w. Eng Rec—Sept. 8, 1906. No. 79037.

The New Terminal Station and Ferry-House of the Delaware, Lackawanna & Western R. R. at Hoboken, N. J. Charles C. Hurlbut. Illustrated detailed description of a fireproof structure erected entirely over water and possessing unique features. 7500 w. Eng News—Sept. 20, 1906. No. 79283.

Tracks.

The Relation of Track Construction to Speed and Weight of Trains. Gives information obtained in reply to an inquiry as to the conditions on a number of railways of different classes. 2000 w. Eng News—Sept. 13, 1906. No. 79170.

Tunnel Tracks.

Track Construction for Railway Tunnels. Gives particulars as to practice, experience and opinions on railways in this country and in England, with editorial discussion of the conditions affecting track and maintenance of way in tunnels. Ills. 6000 w. Eng News—Sept. 20, 1906. No. 79286.

Tunnel Ventilation.

The Ventilation of the Kaiser Wilhelm Tunnel at Cochem, Rhenish Prussia (Die Lüftungsanlage des Kaiser-Wilhelm Tunnel bei Cochem). A. Haas. Describing very fully the installation of a modification of the Saccardo system to the ventilation of the longest tunnel in Germany; the use of petroleum fuel in the locomotives caused much smoke. 6000 w. 2 plates. Glasers Annalen—Aug. 15, 1906. No. 79336 D.

We supply copies of these articles. See page 319.

TRAFFIC.

Co-operation.

Co-operation. Henry W. Thornton. Read before the Traffic Club of Pittsburg. Discusses co-operation between the traffic and operating departments of the same railroad, and co-operation between a railroad and an industry. 6000 w. R R Gaz—Aug. 31, 1906. No. 78966.

Freight.

Some Principles of Freight Traffic Working. W. T. Stephenson. Read before the British Assn. Discusses recent improvements in freight traffic working, —the use of powerful engines and large train loads, the increase in wagon load, etc. 4000 w. Ir & Coal Trds Rev—Aug. 31, and Sept. 7, 1906. Serial. 2 parts. No. 79243, each A.

Mexico.

Mexican Railroads and Railroad Traffic. Samuel H. Barker. Concerning the working of government regulation of railroad rates, and the development of railroads. 2500 w. R R Gaz—Sept. 28, 1906. No. 79497.

Terminals.

How Best to Get Cars Through Large Terminals. W. H. Smith. Read before the Northern Ry. Club. Discusses briefly the changed conditions and suggests a system for forwarding cars. 1300 w. R R Gaz—Sept. 14, 1906. No. 79193.

Tonnage.

Tonnage Rating for Locomotives. Extracts from a paper by F. W. Thomas. Methods for calculating the rating are explained, and the factors entering into the resistance column. 1800 w. R R Gaz—Sept. 21, 1906. No. 79401.

Warehouses.

Relation of Warehousing to Transportation. Ashley J. Elliott. Urges the same diligence in unloading cars as is exercised in unloading vessels. 2500 w. Pro St Louis Ry Club—Aug. 10, 1906. No. 79254.

MISCELLANY.

Acceleration.

Acceleration and Some Locomotive Problems. William G. Raymond. Gives a brief statement of principles and the development of working formulas for determining the acceleration. 4500 w. R R Gaz—Sept. 14, 1906. No. 79191.

Costs.

Unit Costs of Railroad Building. This first paper of a series considers eastern railroads of a first class character, with steel spans, concrete abutments and piers, 80-lb. rail, stone or gravel ballast and permanent construction throughout. Ills. 500 w. R R Gaz—Sept. 7, 1906. Serial. 1st part. No. 79102.

Ireland.

Irish Railways. Reviews what has been done previously for Irish railways in the present number, and gives the names of members of a Vice-Regal Commission to inquire into the present conditions and reports how far they afford adequate facilities, etc. 2800 w. Engr, Lond—Aug. 24, 1906. Serial. 1st part. No. 79018 A.

Italy.

The History and Organization of Italian Railroads. Edward P. North. Historical review, with map. 1200 w. R R Gaz—Sept. 28, 1906. No. 79496.

Mexico.

Railroad Regulation by Law in Mexico. Erdis G. Robinson. Gives some of the important provisions in the excellent railroad law in operation in Mexico. 3500 w. Eng News—Sept. 6, 1906. No. 79089.

The Railroads of Mexico. Harry E. Maule. A review of the existing railways, especially those serving the mining business. 2500 w. Min Wld—Sept. 15, 1906. No. 79210.

STREET AND ELECTRIC RAILWAYS

Brakes.

Advantages and Disadvantages of Different Systems of Tramway Brakes. Gives reports of M. Scholtes, and of M. Bjorkegren, and the conclusions reached by each. 6400 w. Elect'n, Lond—Sept. 7, 1906. No. 79223 A.

Some European Brakes and Their Value. John P. Fox. Describes the relation of braking to skidding, discussing American and English practice, and a series of tests made in England. 6800 w. St Ry Jour—Sept. 15, 1906. No. 79202 C.

Cable Railways.

The Passing of Cable Railways in the United States. Brief outline of the history of this system in Chicago and other cities. 1000 w. Eng News—Sept. 20, 1906. No. 79284.

Chicago.

Superelevation of Tracks and Bridges —Metropolitan West Side Elevated Railway. Describes the raising of these tracks, made necessary by the elevation of railway tracks, which are crossed by this elevated road. Ills. 1100 w. Ry Age—Sept. 14, 1906. No. 79196.

We supply copies of these articles. See page 319.

Electrification.

See Railway Engng., Motive Power.

Florida.

Electric Railway Improvements at Key West, Florida. Frederic H. Porter. Illustrated account of this road and the interesting problems due to climate and soil. 3000 w. Elec Ry Rev—Sept., 1906. No. 79206.

Halifax.

Some Notes on the Operation of the Halifax Electric Tramway Plant. Philip A. Freeman. Briefly describes the plant, the operating and care of the boilers, the engines, etc. 2500 w. Power—Oct., 1906. No. 79459 C.

Interurban.

Interurban Train Testing Apparatus. Sydney W. Ashe. Illustrates and describes a new simple type of train testing set, and reports tests made on new rolling stock of the Brooklyn Rapid Transit Company. 2500 w. St Ry Jour—Sept. 8, 1906. No. 79042 C.

The Rehabilitation of the Philadelphia & West Chester Traction Company's Properties. An illustrated article giving interesting and valuable information in regard to modern interurban practice, and showing how a non-paying country trolley road was made a successful interurban property. 7000 w. St Ry Jour—Sept. 1, 1906. No. 78920 C.

Lake Minnetonka.

The Development of Lake Minnetonka by the Twin City Rapid Transit Company. An illustrated account of the preparations to give ready access to different parts of this beautiful lake near Minneapolis. 2800 w. St Ry Jour—Sept. 8, 1906. No. 79040 C.

Leeds.

The Tramway System of Leeds. Illustrated detailed description of its construction and operation; its history, etc. 13200 w. Tram & Ry Wld—Sept. 6, 1906. No. 79296 B.

Ohio Valley.

The New Ohio Valley Electric Railway Properties. Describes this valley and gives an illustrated detailed description of the new line to be built from Beaver, Pa., to Steubenville, Ohio; a distance of nearly 50 miles. 5000 w. St Ry Jour—Sept. 1, 1906. No. 78921 C.

Overhead.

Continuous vs. Sectionalized Overhead Systems. Prof. G. Rasch. Abstract of a paper at the Milan Convention. Discusses the advantages and disadvantages of the two systems. 1700 w. St Ry Jour—Sept. 22, 1906. No. 79409 C.

Parallel Mileage.

Parallel Mileage of Electric and Steam Railroads. Gives maps of roads in Ohio, Indiana, Illinois, and Michigan principally where high-speed interurban lines parallel steam lines, and discusses the conditions. 4000 w. Ry & Engng Rev—Sept. 8, 1906. No. 79076.

Regulations.

Safety Regulations for Street and Electric Railways (Sicherheitsvorschriften für Elektrische Strassenbahnen und Strassenbahnähnliche Kleinbahnen). Report of the committee of *Verband Deutscher Elektrotechniker*. 7500 w. Elektrotech Zeitschr—Aug. 23, 1906. No. 79354 B.

Shops.

New Repair Shops of the Omaha & Council Bluffs Street Railway Company. Illustrated description of the construction, and the operating methods of large shops. 2200 w. Elec Ry Rev—Sept., 1906. No. 79207.

Simplon.

Electric Traction in the Simplon Tunnel (La Traction Electrique dans le Tunnel du Simplon). S. Herzog. With views of the terminal stations at Brig and Iselle, and a description of the wiring and the locomotives; showing how the difficulties of insulation have been overcome. 2000 w. 1 plate. Génie Civil—Sept. 15, 1906. No. 79322 D.

Station.

Commerce Street Station of the Milwaukee Electric Railway and Light Co. Illustrates and describes an exceptionally compact plant with a novel method of coal handling. 5000 w. Engr, U S A—Sept. 1, 1906. No. 79087 C.

Steel Cars.

Steel Rolling-Stock. George Harrison Sheffield. Abstract of a paper before the Tram. & Lgt. Rys. Assn. Reviews the use made of materials other than timber in the construction of railway cars, and the great changes and improvements that have taken place, especially discussing the designs used on British railways. 4000 w. Elec Engr, Lond—Sept. 7, 1906. No. 79218 A.

Stray Currents.

See Civil Engineering, Water Supply.

Sub-Stations.

Practical Notes on Underground Sub-Stations. W. Pleasance. A consideration of the general design of underground chambers for static transformers and their accompanying switchgear. 2800 w. Elec Rev, Lond—Aug. 31, 1906. No. 79130 A.

Small Railway Substations. W. L. Waters. Considers the requirements of these stations, their operation, the conditions, etc. Ill. 2500 w. Elec Rev, N Y—Sept. 8, 1906. No. 79052.

Wheels.

Cast-Iron and Steel Wheels in City Service. James Andrews. Presents arguments favoring the use of steel wheels. 1700 w. St Ry Jour—Sept. 8, 1906. No. 79043 C.

We supply copies of these articles. See page 319.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *m.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *m.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Electrotechnische Zeitschrift. *w.* Berlin .
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. o fEngineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London .
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarrv. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age . *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Far. *m.* Paris.
Revue Gén .des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.